

WATERSHED BASED PLAN FOR THE THREE FORK CREEK WATERSHED IN THE TYGART VALLEY RIVER DRAINAGE, WEST VIRGINIA

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DRAFT TO WVDEP AND USEPA FOR APPROVAL**

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SUGGESTED REFERENCE

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ABBREVIATIONS

Al	aluminum
AMD	acid mine drainage
AML	abandoned mine land
AMLIS	Abandoned Mine Land Inventory System
BFS	bond forfeiture site
dis.	dissolved
Fe	iron
g	gram
gpm	gallon per minute
L	liter
m ²	square meter
mg/L	milligram per liter
Mn	manganese
MPPRP	Maryland Power Plant Research Project
MRB	manganese removal bed
NMLRC	National Mine Land Reclamation Center
NRCS	Natural Resources Conservation Service
NTU	nephelometric turbidity unit
OAMLRL	Office of Abandoned Mine Lands and Reclamation
OLC	oxic (or open) limestone channel
OSM	Office of Surface Mining, Reclamation and Enforcement
PAD	problem area description
RAPS	reducing and alkalinity producing system
SRG	Stream Restoration Group
TMDL	total maximum daily load
tot.	total
ug/L	microgram per liter
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
WCAP	Watershed Cooperative Agreement Program
WV	West Virginia
WVDEP	West Virginia Department of Environmental Protection
WVDNR	West Virginia Division of Natural Resources

1. INTRODUCTION

This Watershed Based Plan covers the Three Fork Creek watershed (“Three Fork”) of the Tygart Valley River in West Virginia, from its headwaters in Preston County to its mouth in Grafton. Three Fork is impaired by acid mine drainage (AMD) pollutants. This Watershed Based Plan has been written to allow incremental Section 319 funds to be spent in the Three Fork watershed to clean up nonpoint sources that contribute to these pollution problems.

This plan focuses on AMD in Three Fork—by far the most significant water quality problem—and documents the nonpoint sources of AMD. Where data allow, costs of remediating each site are calculated. This plan also addresses technical and financial assistance needs, proposes an implementation schedule with milestones and measurable goals, and documents an outreach and education program that will help make this plan a reality.

1.1 General information

Figure 1 shows the location of the Three Fork Creek watershed. As documented in a recent United States Army Corps of Engineers (USACE) report:

“The Three Fork Creek watershed drains an area 103 mi² and covers portions of Monongalia, Preston, and Taylor Counties. Three Fork Creek enters the Tygart at the town of Grafton, downstream of the Tygart Lake dam. It flows approximately 19 miles, starting at the confluence of Birds Creek and Squires Creek in western Preston County. Headwater streams of Three Fork Creek have elevations up to 2200’; the mouth of Three Fork Creek is at elevation 1000’. The main tributaries of this creek are Squires Creek, Fields Creek, Birds Creek, Laurel Run, and Raccoon Creek. All of these tributaries, except for Laurel Run are impacted with AMD. WVDNR [West Virginia Division of Natural Resources]...determined that Three Fork Creek was the second highest contributor of AMD in the Monongahela River system. In 1977, there were 124 abandoned mines identified in the Three Forks drainage. It has become a contributor to fish kills in the Tygart mainstem during a period when there was low flow from Tygart Lake and high flow from Three Fork...” (USACE, 1997, Appendix F, p. 12)

1.2 Land use and land cover

According to the same report:

“Land use within Three Fork Creek’s watershed is primarily farming and mining. Several small communities exist along the stream and its main tributaries; these include Gladesville, Independence, Newburg, Denver, and Thornton. Grafton and Blueville are located at the mouth of Three Fork Creek.” (USACE, 1997, Appendix F, p 12)

“In the upstream reaches of the Three Fork Creek mainstem much of the stream is bordered with woody riparian vegetation. The riparian areas contain species such as sugar maple, red maple, river birch, oak, and rhododendron. From the community of Three Fork Bridge (two miles downstream of the beginning of Three Fork Creek) to one mile downstream, the creek is bordered by residential areas on one side and by forested hillside on the other. Downstream, the creek is inaccessible by road (for about three miles) until Martin Run near Victoria. This is the only section of the creek that is not bordered by a road. There are three islands in the creek downstream of Victoria. Hemlock, sycamore, and white pine vegetate these islands. Downstream

to the mouth of Raccoon Creek, the riparian area includes trees such as elm, hemlock, sycamore, sugar maple, redbud, and willow.” (USACE, 1997, Appendix F, p. 12)

1.3 Major tributaries

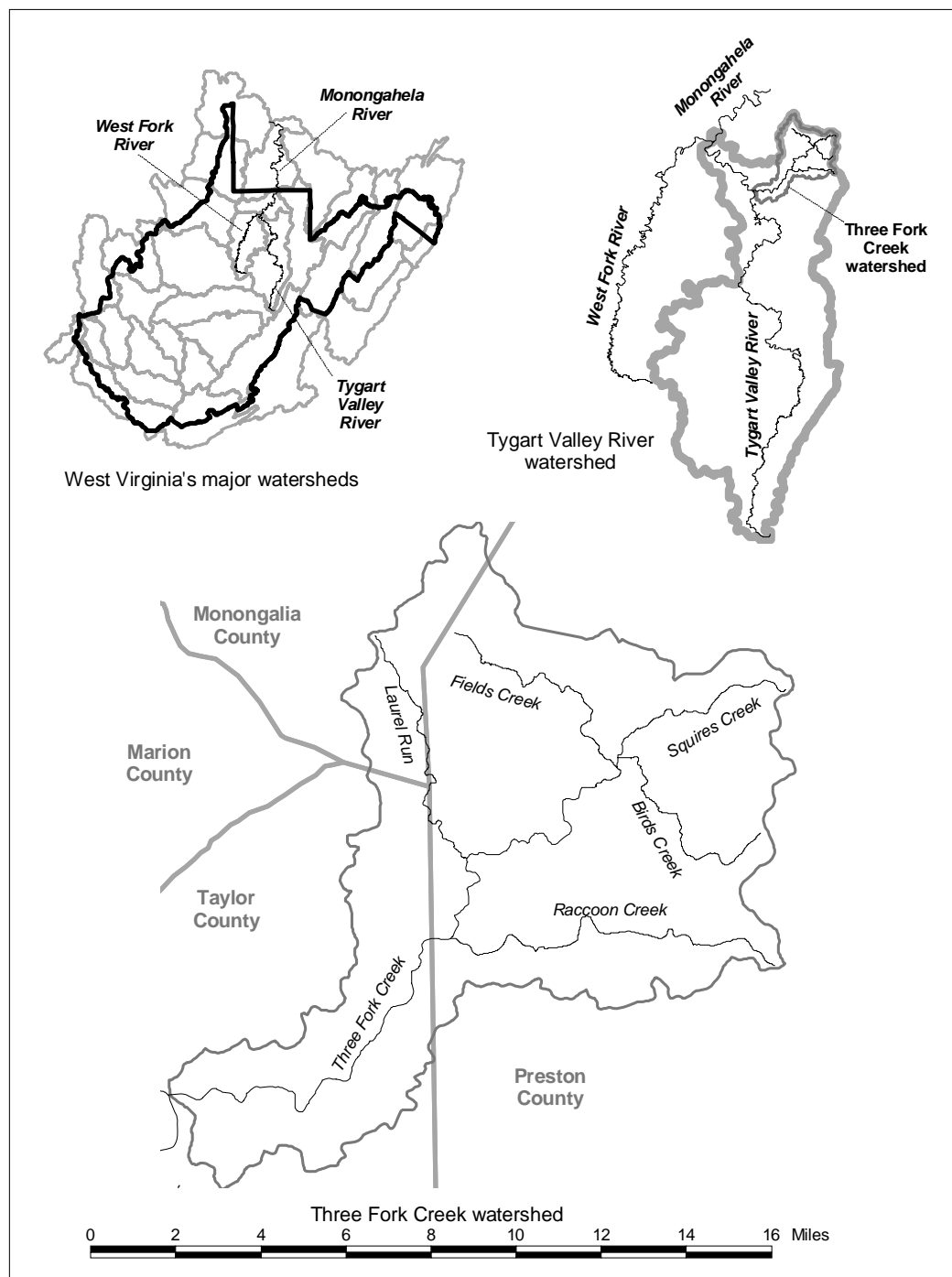
Figure 1 also shows the locations of the major tributaries. According to the same report:

“Fields Creek begins in western Preston County, north of Gladesville, at elevation of 1830’ and flows east/southeast approximately five and one-half miles before it joins with Birds Creek, elevation 1340’. The three main tributaries of Fields Creek are Boyd Run, Brains Creek, and Stoney Run.” (USACE, 1997, Appendix F, pp. 12-13)

“Over two and a half miles of lower Fields Creek is undeveloped and inaccessible by road. NWI [National Wetland Inventory] maps show Fields Creek is bordered by four wetlands between the mouth and Brains Creek.... [Brains Creek]...is bordered by several wetlands in an area inaccessible by road...” (USACE, 1997, Appendix F, p. 13)

“Squires Creek flows west through steeply narrow ravines to join Birds Creek near WV Route 92 south of Browns Mill in Preston County. Squires Creek, including three unnamed tributaries contains approximately 11 miles of perennial streams. Elevations range from 2200’ to about 1340’.” (USACE, 1997, Appendix F, p. 13)

“Birds Creek flows northwest for five miles from Jessop on WV Route 26, Preston County, to the confluence with Squires Creek. One thousand feet below this confluence, Birds Creek enters Fields Creek. Birds Creek has nine tributaries, the largest is eight miles long. Elevation ranges from 2020’ to 1320’. Raccoon Creek starts near Tunnelton in Preston County and flows west through Newburg and Independence to its confluence with Three Fork Creek near the Taylor/Preston County line at Hardman. The main tributaries of Raccoon Creek are Little Raccoon Creek and Cooks Run. The nine mile long creek is bordered by a highway, except for the lower one and one-half miles where it is bordered by a railroad grade. Elevations range from 2000’ to 1100’.” (USACE, 1997, Appendix F, p. 13)

Figure 1: Location and major tributaries of the Three Fork watershed

2. MEASURABLE WATER QUALITY GOALS

All stream segments in the Three Fork watershed should, at a minimum, be fishable and swimmable, and should be clean enough to contain healthy communities of indigenous aquatic species. The federal Clean Water Act, state Water Pollution Control Act, and federal and state regulations have determined a set of interlinked water quality goals. Designated uses for the streams in the Three Fork watershed include public water supply (Category A), maintenance and propagation of aquatic life (warm water fishery streams) (Category B1), maintenance and propagation of aquatic life (trout waters) (Category B2), and water contact recreation (Category C). The numeric and narrative water quality standards shown in Table 1 are relevant for the nonpoint source pollution problems addressed by this Watershed Based Plan.

Table 1: Selected West Virginia water quality standards

Parameter	Section	Aquatic life		Human health	
		Category B1 (Warm water fishery streams)	Category B2 (Trout waters)	Category A (Public water supply)	Category C (Water contact recreation)
Aluminum (dissolved)	8.1	Not to exceed 87 µg/L (chronic) or 750 µg/L (acute)		None	None
Iron (total)	8.15	Not to exceed 1.5 mg/L (chronic)	Not to exceed 0.5 mg/L (chronic)	Not to exceed 1.5 mg/L	None
Manganese (total)	8.17	None	None	Not to exceed 1.0 mg/L	None
pH	8.23	No values below 6.0 nor above 9.0. Higher values due to photosynthetic activity may be tolerated.			
Turbidity	8.32	No point or non-point source to West Virginia's waters shall contribute a net load of suspended matter such that the turbidity exceeds 10 NTUs over background turbidity when the background is 50 NTU or less, or have more than a 10% increase in turbidity (plus 10 NTU minimum) when the background turbidity is more than 50 NTUs.			

Source: 46 Code of State Rules Series 1. Sections refer to this rule. When the TMDL was approved, the manganese criterion applied to all waters. The United States Environmental Protection Agency (USEPA) has recently approved a modification to this criterion: "The manganese human health criterion shall only apply within the five-mile zone immediately upstream above a known public or private water supply used for human consumption." When the TMDL was approved, an acute total aluminum criterion of 750 µg/L was in effect. Since then, the aluminum criterion was changed to dissolved aluminum, and a chronic criterion was added. Also, the chronic dissolved aluminum criterion of 87 µg/L has been suspended in all but trout waters until July 2007. USEPA has still not approved or disapproved this suspension. See Sections 8.32 and 8.32.1 for special circumstances for the turbidity standard. ug/L = micrograms per liter. NTU = nephelometric turbidity unit.

As explained in the notes for Table 1, the aluminum and manganese criteria have become more lenient since 2001, when the total maximum daily load (TMDL) for this watershed was approved. Therefore, the TMDL's aluminum and manganese load reduction requirements may be more stringent than required to meet current water quality standards.

3. SOURCES OF NON-POINT SOURCE POLLUTION THAT MUST BE CONTROLLED

Streams that do not meet water quality standards are placed on a statewide list of impaired streams called the 303(d) list. Improving water quality so that these streams are once again clean and can be removed from this list is the primary goal of this plan. Segments of the Three Fork watershed covered by this plan are on the 2004 303(d) list for AMD-related pollutants: pH, aluminum, iron, and/or manganese.

The most important nonpoint source pollution in the Three Fork watershed is AMD from abandoned mine lands (AMLs). The West Virginia Department of Environmental Protection's (WVDEP's) most recent 303(d) list (WVDEP, 2004) lists specific segments of the watershed as impaired by high concentrations of iron, aluminum, and manganese, and by low pH from AMD. Table 2 lists these AMD-impaired streams, and Figure 2 draws them as thick, grey lines.

Table 2: Stream segments impaired by acid mine drainage in the Three Fork watershed

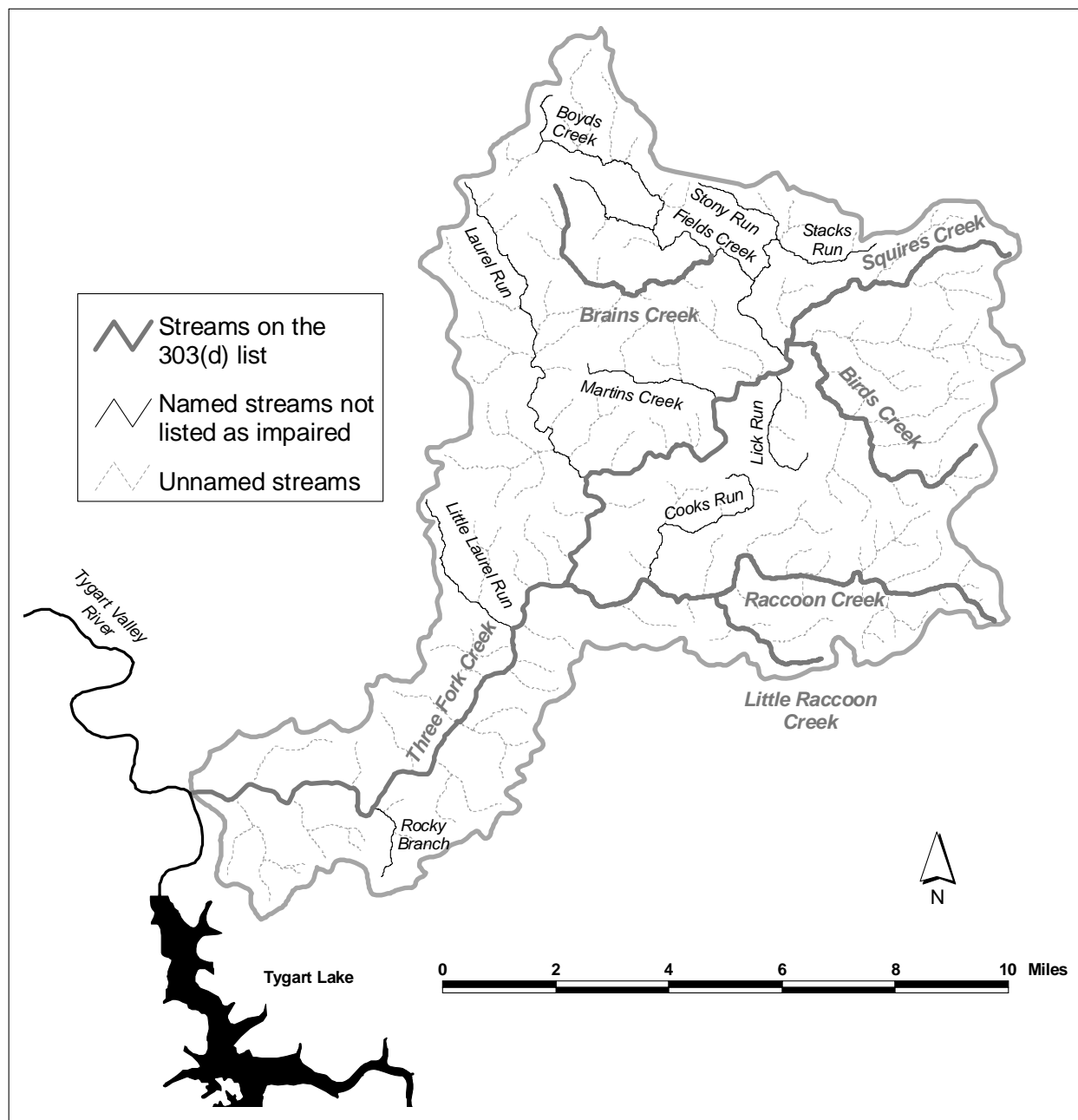
Stream code	Stream name	Miles impaired	Al (dis.)	Al (tot.)	Fe	Mn	pH
MT-12	Three Fork Creek	19	x	X	x	x	x
MT-12-C	Raccoon Creek	8.8	x	X	x	x	x
MT-12-C-2	Little Raccoon Creek	2.6		X	x	x	
MT-12-G-2	Brains Creek	4.9		X	x	x	x
MT-12-H	Birds Creek	5.5		X	x	x	x
MT-12-H-1	Squires Creek	4.5		X	x	x	x

Source: All impairments except total aluminum are from the 2004 303(d) list Supplemental Tables B and E (WVDEP, 2004), which lists 19 impaired miles for dissolved aluminum for Three Fork Creek, but no mileages for the any other AMD impairments. Total aluminum impairments are from the 2002 303(d) list, which does not provide any mileages (WVDEP, 2003). Impaired mileages for all streams are from the 1998 303(d) list (WVDEP, 1998), which lists all streams as impaired by pH and metals from mine drainage.

A total of 80 AMLs are documented in the Three Fork watershed and are listed in Appendix A. The problem area descriptions (PADs) and other documentation of these sites indicate that only those 38 AMLs in Table 3 discharge AMD (WVDEP, Various dates).

Other AMLs likely do not discharge AMD; therefore, they are only listed in Appendix A. The methods used to identify sites in Table 3 and Appendix A are not foolproof. If new information indicates that an AML that was left out of Table 3 does, in fact, discharge AMD, the Watershed Based Plan will be updated as appropriate.

Three Fork is also impaired by bond forfeiture sites (BFSs) that discharge AMD, as shown in Table 4. These sites often contribute a significant amount of AMD and in some cases may account for most or all of the pollution in a subwatershed. However, BFSs are considered to be point sources and are not eligible for Section 319 funding. These sites are therefore not covered in detail in this plan.

Figure 2: Impaired streams in the Three Fork watershed

Source: WVDEP (2004, 2003, and 1998).

Table 3: Abandoned mine lands known to discharge acid mine drainage

Site name (Problem area no.)	Notes	TMDL subwatershed
<u>Direct drains to Three Fork Creek</u>		
Three Forks #2 (982)	Between Raccoon and Laurel	66
Three Forks #3 (983)	Between Raccoon and Laurel	66
Irontown Refuse (1723)	Downstream of Raccoon	79
<u>Raccoon Creek</u>		
West End Portals and Structures (470)		58
Maple Run Portals & AMD (900)		67
West End #1 (1547)		58
Raccoon Creek Refuse #2 (1728)		67
Austen Refuse (1738)		56
Cooks Run Refuse (1741)		54
Newburg Tipple and Refuse (1746)		64
Austen Highwall #2 (2410)		56
Austen Highwall #3, Refuse (2411)		56
Knotts Strip #1 (3547)	Also drains to Birds	56, 54, 37
Raccoon Creek Highwall (3548)		55
Raccoon Creek Refuse and Coke Ovens (4971)		56
<u>Brains Creek</u>		
Browns Chapel Strips (1777)		11
Summers (2351)		11
<u>Birds Creek</u>		
Birds Creek #7 (1077)		19
Birds Creek #4 (1083)		38
Bird's Creek Portals (1085)		19
Howesville Portals (1743)		15
Hopewell Church Refuse and Drainage (1744)		15
Hopewell Strip #2 (2414)		16
Concord (Conley) Highwall (2919)		37
Irish Ridge #2 (2920)		16
Jessop Strip #1 (2984)		41
Jessop Portal & Highwall (3362)		41
Shaffer Strip (3454)		41
<u>Squires Creek</u>		
Pell School Strip #2 & Portal (1078)		8
Bethlehem Church Refuse (1745)		7
Paul Ellison (2196)		10
Mt. Phoebe Portal and Highwall (2406)		7
Borgman Refuse and Portals (5409)		7
Squires Creek Refuse & Portals (5758)		7
<u>STREAMS NOT LISTED AS IMPAIRED</u>		
<u>Little Laurel Run</u>		
Three Forks Refuse #4 & #5 (1731)	Also drains to Three Fork	78, 79
<u>Cooks Run</u>		
Sharp's Highwall (2409)		62
Cooks Run AMD, Highwall & Portals (5004)		62
<u>Fields Creek</u>		
Boyd Run Strip South (2785)		5

Source: WVDEP (Various dates). TMDL subwatersheds are enumerated in USEPA (2001).

Table 4: Bond forfeiture sites in that discharge acid mine drainage

Company	Mining permit	Construction date	TMDL subwatershed
<u>Raccoon Creek</u>			
Inter-State Lumber Company, Inc.	S-52-83		55
Beefsteak Mining Co.	S-1087-86		57
Maurice Jennings	53-78	9/08	67
<u>Little Raccoon Creek</u>			
Maurice Jennings	S-61-83	9/08	65
<u>Brains Creek</u>			
ED-E Development Co., Inc.	S-10-81		11
VMS, LTD.	S-1045-87	6/07	11
<u>Birds Creek</u>			
Inter-State Lumber Company, Inc.	S-96-82	6/06	41
K. C. & M. Coal Company, Inc.	S-1023-88	6/07	15
Preston Energy, Inc.	O-1035-87		40
Preston Energy, Inc.	O-43-85		41
Preston Energy, Inc.	O-86-82		15
<u>Squires Creek</u>			
ED-E Development Co., Inc.	S-1032-86		7

Source: McCarthy (2005). If construction dates are not shown, projects have been contracted or completed. TMDL subwatersheds are enumerated in USEPA (2001).

Table 5 summarizes whether AMLs, BFSs, or both discharge AMD to each impaired stream segment. Ten of the thirteen subwatersheds for which the TMDL requires load reductions are known to receive AMD from nonpoint source AMLs. These ten watersheds are highlighted in Table 5 and are the focus of the Watershed Based Plan. Eleven additional subwatersheds have AML sources of AMD but do not have load reductions assigned by the TMDL. Because the data resolving pollutant loads to subwatersheds are sparse, these additional eleven subwatersheds are also assumed to require treatments to reduce pollutant loads.

Table 5: Known and likely sources of acid mine drainage by subwatershed

Stream code	Stream name	TMDL Sub-watershed	TMDL requires reductions			AMD sources	
			Al	Fe	Mn	BFS	AML
MT-12	Three Fork between Raccoon and Laurel	66					x
MT-12	Three Fork downstream of Raccoon	79					x
MT-12-C	Raccoon Creek	54					x
		55	x	x	x	x	x
		56	x	x	x		x
		57	x	x	x	x	
		58	x	x	x		x
		64					x
		67				x	x
MT-12-C-2	Little Raccoon Creek	65				x	
MT-12-G-2	Brains Creek	11	x	x	x	x	x
MT-12-H	Birds Creek	15	x	x	x	x	x
		16	x	x	x		x
		17	x	x	x		
		19		x	x		x
		37					x
		38					x
		40	x	x	x	x	
		41	x	x	x	x	x
MT-12-I	Squires Creek	7	x	x	x	x	x
		8	x	x	x		x
		10					x
<u>Streams not listed as impaired</u>							
MT-12-B	Little Laurel Run	78					x
MT-12-C-1	Cooks Run	62					x
MT-12-G	Fields Creek	5					x

Source: TMDL subwatersheds and pollutants that require reductions are enumerated in USEPA (2001). BFS information from Table 4. AML information from Table 3. TMDL subwatersheds are shaded if the TMDL requires reductions and if AMLs are known to discharge AMD.

4. NONPOINT SOURCE MANAGEMENT MEASURES

The following list describes in depth the various measures that may be used to control AMD. Numbers in parentheses following the name of the method indicate the potential load reductions when the method is used correctly and in the proper situation.

4.1 Land reclamation

- **Removing acid-forming material (95%).** This method has the potential to eliminate the acid load completely if all of the acid-forming material can be removed. In the context of the Three Fork watershed, this method is unlikely to eliminate the loads to the watershed or the subwatersheds, because acid-forming materials do not seem to be gathered in small areas, and because where such materials are on the surface, there are other sources of AMD nearby. Furthermore, the cost of removing the materials is much greater than the cost of covering them with an impervious layer and revegetating the cap.
- **Isolating acid-forming material from flowpaths (50%).** See the next two items. It is difficult to estimate the efficacy of these measures exactly. On the one hand, some AMD is often visible seeping from the edges reclaimed areas. On the other hand, a measurement of AMD loads frequently shows such seeps are small compared to loads from nearby mine openings.
- **Sealing from above.** Infiltration of water into acid-forming material can be slowed by covering the material with low-permeability material, such as clay, and covering that layer with a vegetated layer to stabilize it. Effective reclamation and revegetation can eliminate a large proportion of the AMD from a given site.
- **Isolating from below.** Interactions between water and acid-forming materials can be further minimized by separating the waste material from impermeable bedrock below with conductive materials. Water may then flow beneath the spoil and be conducted away from it rapidly, so the water table does not rise into the spoil.
- **Surface water management.** Rock-lined ditches or grouted channels can be used to convey surface water off site before it can percolate into acid-forming material. Limestone is often used in such channels to neutralize acidity, as with oxic limestone channels (OLCs), discussed below.

4.2 Passive AMD treatment

- **Reducing and Alkalinity Producing Systems (RAPSS) (25 g acidity/m²).** In these systems, also known as “successive alkalinity producing systems” and “vertical flow ponds,” water encounters two or more treatment cells in series. First, water passes through organic material to deplete dissolved oxygen. Several helpful reactions take place in the anoxic environment. First, bacteria reduce sulfate in an alkalinity producing reaction. Second, ferric iron, which comes into contact with pyrite, should reoxidize the sulfur and turn to ferrous iron. In a second cell, the anoxic solution comes into contact with limestone. H⁺ acidity is neutralized through contact with the limestone. Additional alkalinity dissolves into the water as well. Iron does not armor the limestone because it is the ferrous form. Water then runs through an aeration and settling pond, in which ferrous iron oxidizes and then precipitates out of solution as ferric hydroxide. The acidity released in this process is neutralized by the alkalinity that has accumulated in the solution.
- **Sulfate-reducing bioreactors (40 g acidity/m²).** These systems also consist of organic matter and limestone, but in sulfate-reducing bioreactors, the materials are all mixed in a single cell. Some of the organic material included is of a coarser nature, such as sawdust or woodchips. Reactions in these systems are similar to those in RAPSS: compost eliminates oxygen, and drives the iron and sulfur to reduced forms. The coarser organic matter may serve to protect hydraulic conductivity and may retain metals as various organic complexes.

- **Manganese removal beds (MRBs) (to 2 mg/L).** Manganese may be removed from AMD either by active treatment (Section 4.1.3) or by MRBs. In MRBs, water is passed over a wide limestone bed, and dissolved manganese oxidizes and precipitates from solution.
- **Oxic (or Open) limestone channels (30%).** Research to estimate the efficacy of OLCs is active. OLCs have the advantage that continually moving water may erode any armoring from limestone, and that water flow should remove precipitates from OLCs so that they do not interfere with acid neutralization. In practice, the efficacy of OLCs may suffer because they are too short, most limestone may be placed so as to react with water only at high flows, and fluctuating water levels enhance armoring. Recent research suggests that the acid neutralization that takes place in OLCs is actually greater than can be accounted for by limestone dissolution.
- **Limestone leachbeds (50%).** Limestone leachbeds are most effective when water has a pH of 3 or less, and when water retention times are short (~90 minutes). The low pH promotes rapid limestone dissolution, but the short retention time prevents armoring.
- **Steel slag leachbeds (addition of alkalinity).** Steel slag leachbeds are not exposed to AMD. Rather, circumneutral feed water passes through these leachbeds, and that water is then mixed with AMD to reduce its acidity drastically.
- **Compost wetlands (wide range).** Constructed wetlands can serve multiple functions in AMD treatment. Wide areas of exposure to the atmosphere allow metals in solution to oxidize. Slower waters allow precipitates to fall out of suspension. Anaerobic zones in sediments allow for sulfate reduction, which consumes acidity. Inclusion of limestone in the substrate provides an additional alkalinity source and helps maintain conditions that support sulfate reduction.
- **Grouting (50%).** Setting up grout walls or curtains in deep mines has great potential to solve AMD problems. Ideally, such barriers may serve to keep water from entering mines and interacting with acid-forming materials. They must be constructed carefully so as not to build water pressures near a weak point and to avoid blowouts. Also, fractures in bedrock always allow some water into mines, even if flows are eliminated. A grouting project at Winding Ridge, near Friendsville, Maryland, decreased acidity by 50% (MPPRP, 2000).

4.3 Active AMD treatment

- **Treating (100+%).** A variety of active treatment methods exist for AMD. One of a number of alkaline chemicals can be mixed with the polluted water. The mixture may then be aerated and is finally passed through ponds allowing metal hydroxides to settle out as sludge.

5. LOAD REDUCTIONS AND COSTS

The TMDL for the Tygart Valley River watershed, which includes the Three Fork watershed, set goals for pollutant reductions from nonpoint and point source activities that, if enacted, should improve water quality so that the stream segments are removed from the 303(d) list and meet standards (USEPA, 2001). While the TMDL calls for wasteload allocations for specific point sources, load allocations for nonpoint sources are not tied to specific AMLs. Instead, the load allocations are provided for each TMDL subwatershed. If all wasteload and load allocations for aluminum, iron, and manganese are met, the TMDL asserts that the water quality criteria for pH will also be met (USEPA, 2001).

As noted in Chapter 2, the aluminum and manganese criteria have become more lenient since the TMDL was approved. The aluminum and manganese TMDL targets therefore may be more stringent than required to meet current water quality standards, and the costs calculated in this chapter may be overestimates. In particular, for streams in which the manganese criterion no longer applies, the costs of MRBs may be entirely avoided. Because the TMDL has not been updated to account for these water quality standard changes, this Watershed Based Plan calculates load reductions and costs based on the standards in place when the TMDL was approved.

Table 6 lists the load allocations from the TMDL in the “TMDL target” column. Current loads for each site are also estimated using four different methods. Calculations are described in Appendix B. The treatment measures proposed for each site are sized with the goal of reducing the loads to meet the TMDL targets; therefore, implementation of this Watershed Based Plan should reduce loads to meet the TMDL targets. If measures are implemented and targets are still not met, it may be necessary to collect more data and to design additional treatment measures.

Treatment systems for each site are chosen based on the assumption that Section 319 funds will continue to be limited to funding capital costs. Treatment options are therefore limited to land reclamation and passive systems that do not require ongoing operations and maintenance. Load reductions and costs are based on what can reasonably be achieved by land reclamation or installing appropriate passive treatment systems.

AMD may be generated within accumulations of mine spoil or refuse on the surface, or in similar acid forming materials located in underground mines. If site descriptions suggest that materials on the surface are responsible for the AMD, then the remediation cost is determined according to the acres of land requiring reclamation. In some cases, spoil piles may be large and adequately vegetated, and passive water treatment may be more cost effective.

When AMD flows out of underground mines, a passive treatment system can be chosen and sized based on water chemistry and flow data. The appropriate passive water treatment system for the sources that have been studied in nearby watersheds is a RAPS, according to Watzlaf et al. (2004). Net acidity in the water rules out treatment with only aerobic wetlands. Concentrations greater than 1 mg/L of dissolved oxygen, aluminum, or iron in the ferric state rule out the use of anoxic limestone drains. It is also assumed that deep mine AMD sources that have not been carefully examined will also produce water requiring RAPSs. RAPSs are sized according to the acidity load from the AMD source. Detailed sizing and cost assumptions are included in Appendix C.

Because RAPSs are not designed to treat manganese, MRBs are also included in the cost estimates. MRBs are sized to achieve a 24-hour retention time, which has proven effective for manganese removal. Detailed sizing and cost assumptions for MRBs are also included in Appendix C.

The Office of Surface Mining, Reclamation and Enforcement's (OSM's) AMDTreat computer program is used to calculate costs for both RAPSs and MRBs. Table 7 summarizes the cost calculations performed in this Watershed Based Plan: To meet TMDL targets for 45.3 miles of impaired streams, it will cost more than \$7.38 million.

Table 6: Reductions required to meet TMDL targets for abandoned mine lands

Stream code	Stream name	Pollutant	Current load estimates (pounds/year)				TMDL target (pounds/year)	Required reduction
			Sum of AML discharges	Save the Tygart monitoring data	WVDEP monitoring data	TMDL baseline		
MT-12	Three Fork Creek	Al			~0	23,466	4,720	80%
		Fe			~0	69,446	12,373	82%
		Mn			64,600	20,140	7,219	89%
MT-12-C	Raccoon Creek	Al	59,511	256,708	91,600	6,820	1,229	100%
		Fe	87,884	58,734	6,800	20,148	3,891	96%
		Mn	12,179	73,586	22,100	4,339	1,622	98%
MT-12-C-2	Little Raccoon Creek	Al			700	38	38	95%
		Fe			100	35	35	65%
		Mn			900	57	57	94%
MT-12-G-2	Brains Creek	Al			18,800	15	15	100%
		Fe			0	14	14	0%
		Mn			10,200	22	22	100%
MT-12-H	Birds Creek	Al	9,372		174,900	9,287	2,313	99%
		Fe	11,775		12,900	26,885	6,008	78%
		Mn	2,298		42,000	10,874	3,962	91%
MT-12-H-1	Squires Creek	Al	37,909		99,200	6,801	615	99%
		Fe	62,932		25,600	21,786	1,847	97%
		Mn	6,492		25,300	4,164	872	97%

Note: Sum of AML discharges calculations are shown in Appendix B. Save the Tygart monitoring data consist of eight samples collected between January 2004 and October 2005. WVDEP monitoring data consists of a single sampling sweep in October 2000. According to these monitoring data, virtually all of the acidity, Al, and Fe loads to the Three Fork watershed as a whole may be traced to its tributaries; therefore, Al and Fe load estimates are zero. TMDL targets are load allocations for each pollutant in each subwatershed from USEPA (2001). Required reduction calculations assume the highest load is correct.

Table 7: Summary of costs and stream miles improved

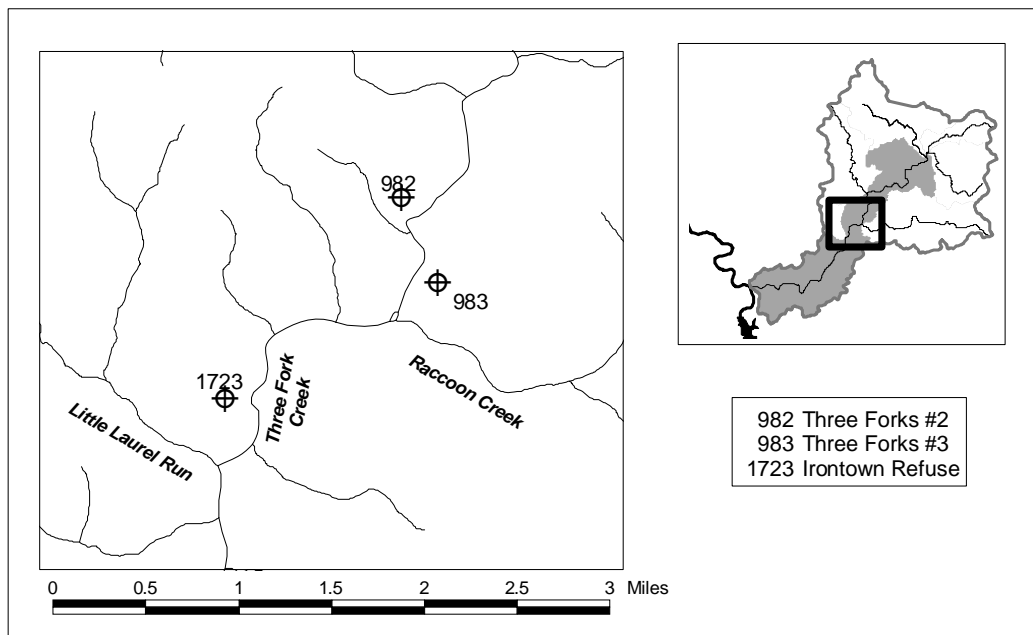
Stream name	Stream code	Impaired miles	Estimated future cost for water remediation
Three Fork Creek	MT-12	19	\$160,000
Raccoon Creek	MT-12-C	8.8	>\$2,430,000
Little Raccoon Creek	MT-12-C-2	2.6	No estimate possible
Brains Creek	MT-12-G-2	4.9	\$860,000
Birds Creek	MT-12-H	5.5	>\$1,180,000
Squires Creek	MT-12-H-1	4.5	>\$2,260,000
Streams not listed as impaired	MT-12-B, MT-12-C-1, MT-12-G	0	\$490,000
Total		45.3	>\$7,380,000

Source: Impaired miles from Table 2. Estimated future costs for water remediation are calculated in this Watershed Based Plan, as detailed below. Subwatersheds not listed as impaired include Little Laurel Run, Cooks Run, and Fields Creek. These tributaries are not listed even though AMLs discharging AMD are present. It is likely that further monitoring will reveal some impairment.

5.1 Direct drains to Three Fork Creek

Direct drains to Three Fork Creek (MT-12) include TMDL subwatersheds 66 and 79.

Figure 3: Abandoned mine lands in direct drains to Three Fork Creek



Note: Symbols are located at coordinates given by the Abandoned Mine Land Inventory System (AMLIS) database. AMLs usually encompass surrounding areas.

Table 8: Costs and descriptions of abandoned mine lands in direct drains to Three Fork Creek

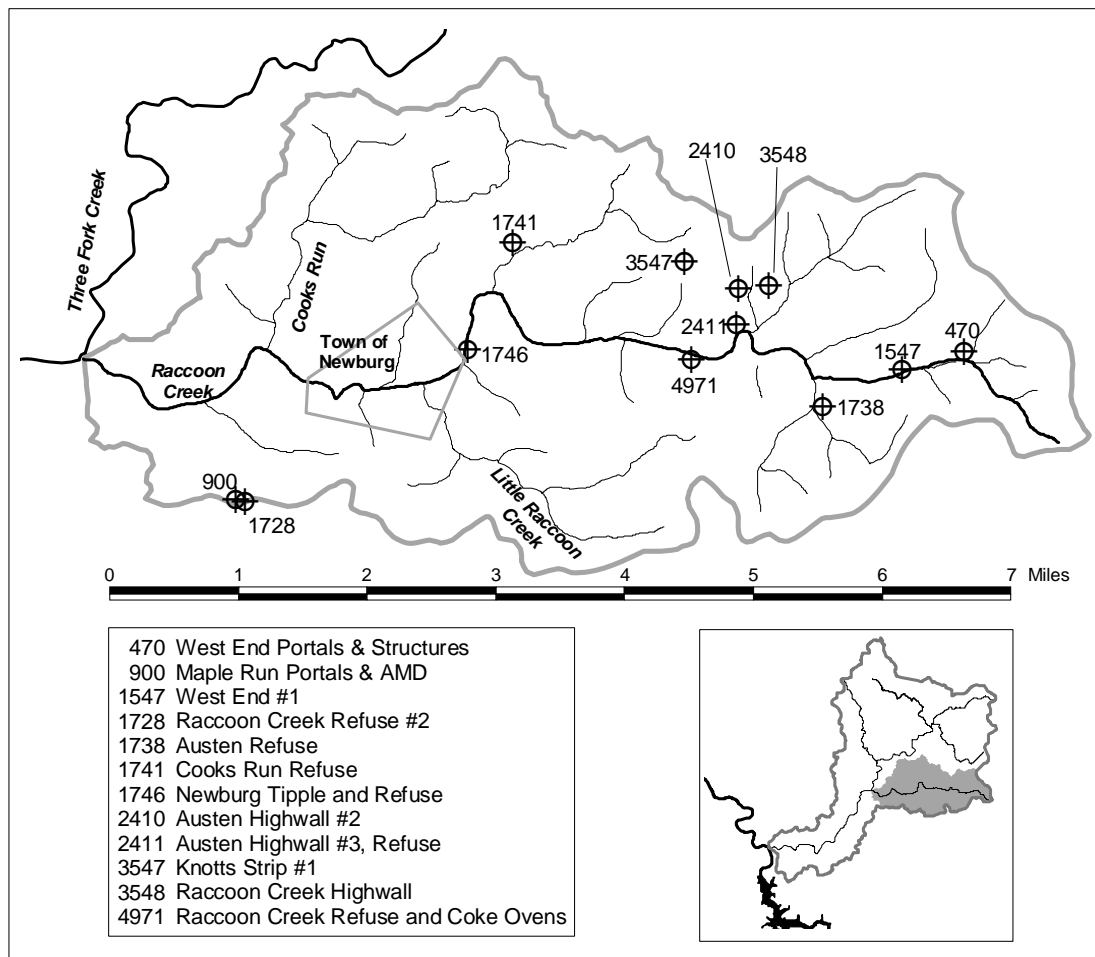
Site name (Problem area no.)	Past reclamation cost	Site and cost description	Estimated future cost for water remediation
Three Forks #2 (982)	\$0	AMD is impounded within portals but is not flowing out. Reclaim sufficient area to give this water some alkalinity and prevent it from interacting with acid materials.	\$110,000
Three Forks #3 (983)	\$0	A small amount of refuse coal must be reclaimed.	\$30,000
Irontown Refuse (1723)	\$0	A small amount of refuse coal must be reclaimed.	\$20,000
Total, Direct drains to Three Fork Creek			\$160,000

Source: Past reclamation costs from OSM (2005a). Site and cost descriptions from OSM (2005a) and WVDEP (Various dates). Estimated future costs for water remediation calculated in this plan.

5.2 Raccoon Creek

Raccoon Creek (MT-12-C) includes TMDL subwatersheds 54-59, 63, 64, and 67.

Figure 4: Abandoned mine lands in the Raccoon Creek watershed



Note: Symbols are located at coordinates given by the AMLIS database. AMLs usually encompass surrounding areas.

Table 9: Costs and descriptions of abandoned mine lands in the Raccoon Creek watershed

Site name (Problem area no.)	Past reclamation cost	Site and cost description	Estimated future cost for water remediation
West End Portals & Structures (470)	\$1,497,493	Complaints that were addressed at this site include highwall, impoundments, clogged streams, piles and embankments, and hazardous facilities, but not water pollution. AMD flowing from portals must be addressed. This site is currently being monitored by Save the Tygart in preparation for a remediation project.	\$120,000
Maple Run Portals & AMD (900)	\$224,662	This problem area has three sites, only one of which is in the Three Fork watershed. No work was completed on that site, where portals discharge AMD.	\$490,000
West End #1 (1547)	\$0	Reclaimed, at least in part, with Austen Highwall #3, Refuse (2411).	See 2411
Raccoon Creek Refuse #2 (1728)	\$0	A small refuse coal area must be reclaimed.	\$20,000
Austen Refuse (1738)	\$0	A small flow of AMD requires passive treatment, and refuse coal must be reclaimed.	\$100,000
Cooks Run Refuse (1741)	\$0	Refuse coal must be reclaimed.	\$240,000
Newburg Tipple and Refuse (1746)	\$0	Refuse coal must be reclaimed.	\$50,000
Austen Highwall #2 (2410)	\$45,000	A coal processing area ("slurry") must be reclaimed.	\$110,000
Austen Highwall #3, Refuse (2411)	\$578,673	Extensive reclamation work on this site together with West End #1 (1547) did not address the water pollution complaints at these sites. Large passive treatment systems would be needed.	>\$1,000,000
Knotts Strip #1 (3547)	\$0	There is a small flow of AMD requiring passive treatment. In addition, areas where water gathers should be reclaimed to prevent the water from becoming polluted.	\$190,000
Raccoon Creek Highwall (3548)	\$0	Areas where water gathers should be reclaimed to prevent the water from becoming polluted.	\$50,000
Raccoon Creek Refuse and Coke Ovens (4971)	\$0	Refuse coal must be reclaimed.	\$60,000
Total, Raccoon Creek watershed			>\$2,430,000

Source: Past reclamation costs from OSM (2005a). Site and cost descriptions from OSM (2005a) and WVDEP (Various dates). Estimated future costs for water remediation calculated in this plan.

5.3 Little Raccoon Creek

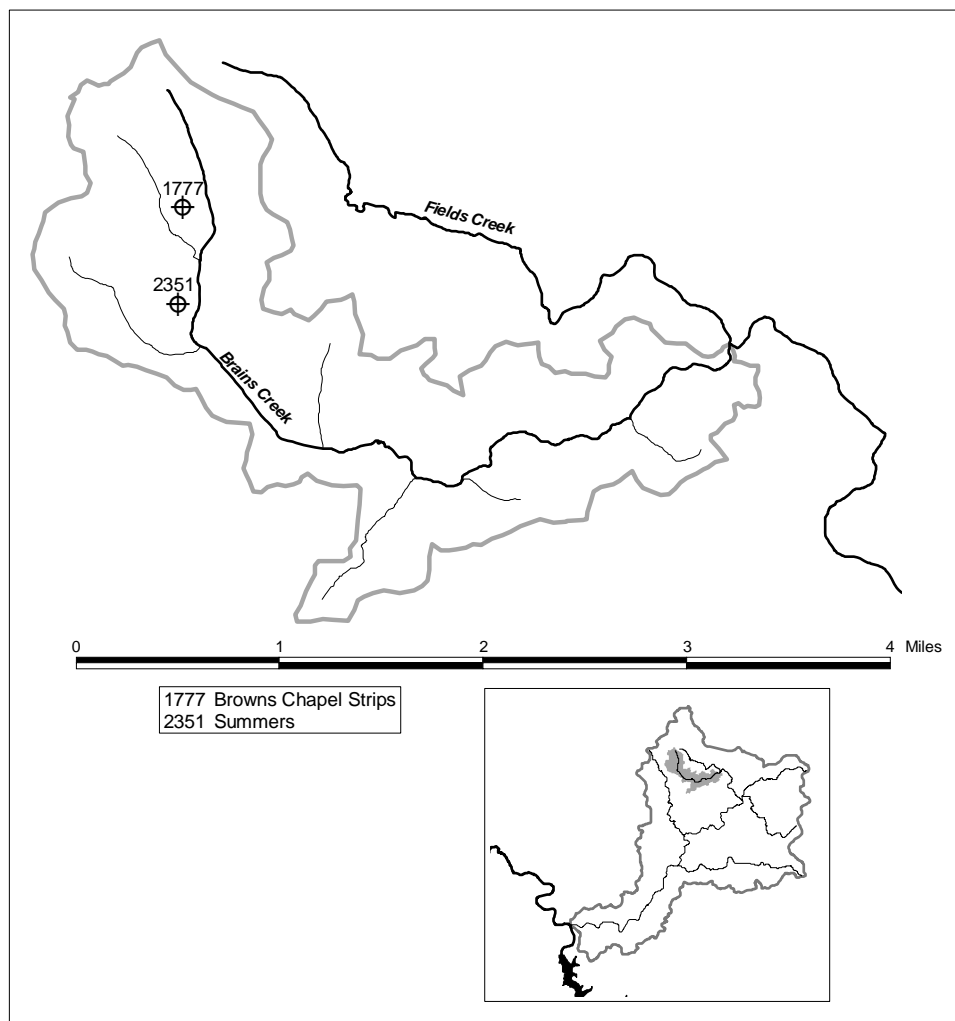
Little Raccoon Creek (MT-12-C-2) includes TMDL subwatershed 65. No problem areas were identified that contribute to Little Raccoon Creek. Furthermore, although it is impaired, the TMDL does not call for load reductions in SWS 65. SRG data (WVDEP, 2005c) indicate that the stream is only mildly impaired, with pH values ranging from 5.7 to 6.6. SRG's single measurement of metal loads exceeds the TMDLs for the subwatershed.

Additional monitoring in this subwatershed will be required before it can be treated and removed from the 303(d) list. However, it is probably not adding significantly to the pollution loads in Raccoon Creek.

5.4 Brains Creek

Brains Creek (MT-12-G-2) includes TMDL subwatershed 11.

Figure 5: Abandoned mine lands in the Brains Creek watershed



Note: Symbols are located at coordinates given by the AMLIS database. AMLs usually encompass surrounding areas.

Table 10: Costs and descriptions of abandoned mine lands in the Brains Creek watershed

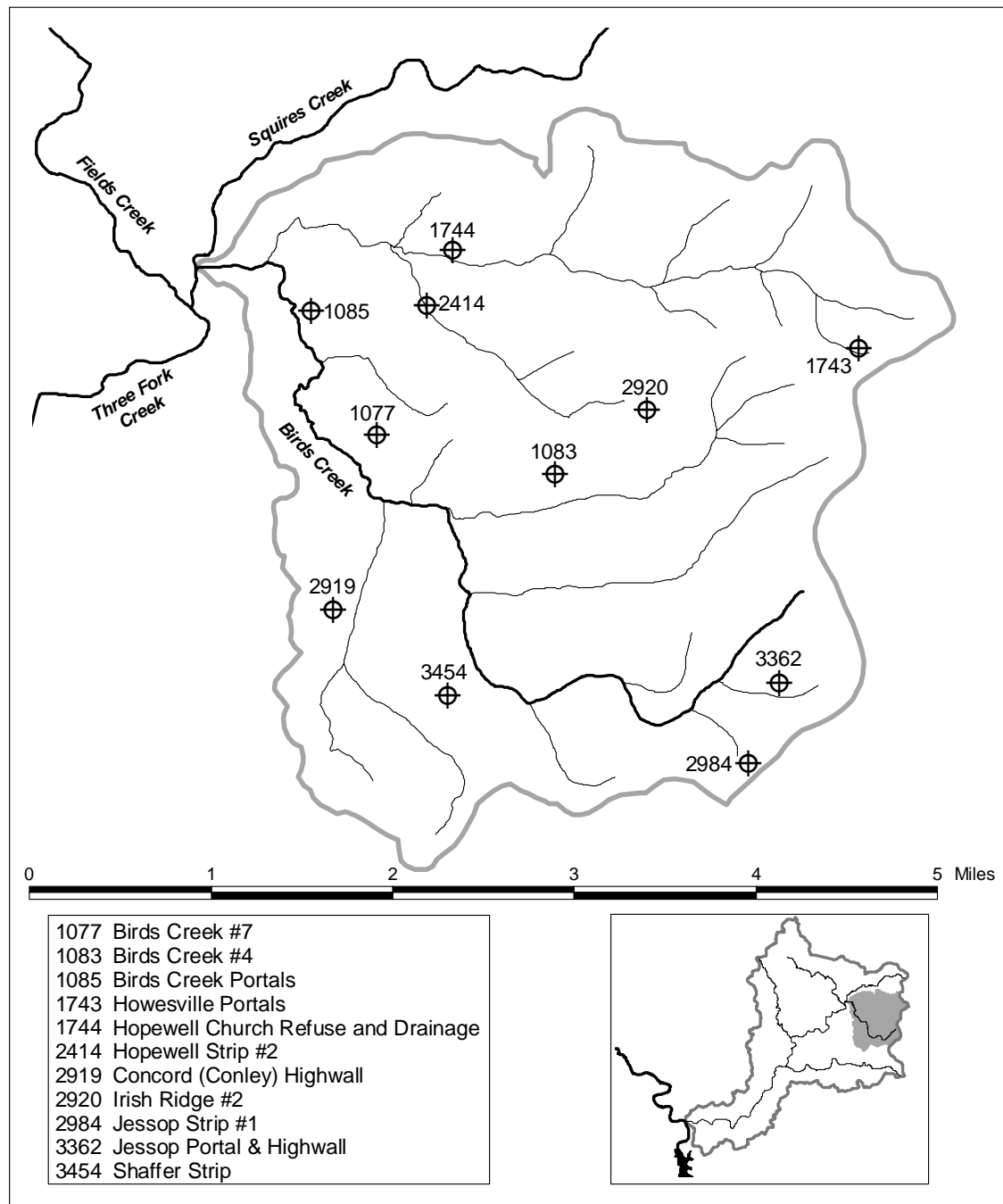
Site name (Problem area no.)	Past reclamation cost	Site and cost description	Estimated future cost for water remediation
Browns Chapel Strips (1777)	\$0	Refuse and spoil are mixed over a 50-acre area.	\$810,000
Summers (2351)	\$0	AMD is reported to come out of the ground, probably from refuse that needs to be reclaimed. No flows were estimated.	\$50,000
Total, Brains Creek watershed			\$860,000

Source: Past reclamation costs from OSM (2005a). Site and cost descriptions from OSM (2005a) and WVDEP (Various dates). Estimated future costs for water remediation calculated in this plan.

5.5 Birds Creek

Birds Creek (MT-12-H) includes TMDL subwatersheds 15-17, 19, 20, 34, and 37-41.

Figure 6: Abandoned mine lands in the Birds Creek watershed



Note: Symbols are located at coordinates given by the AMLIS database. AMLs usually encompass surrounding areas.

Table 11: Costs and descriptions of abandoned mine lands in the Birds Creek watershed

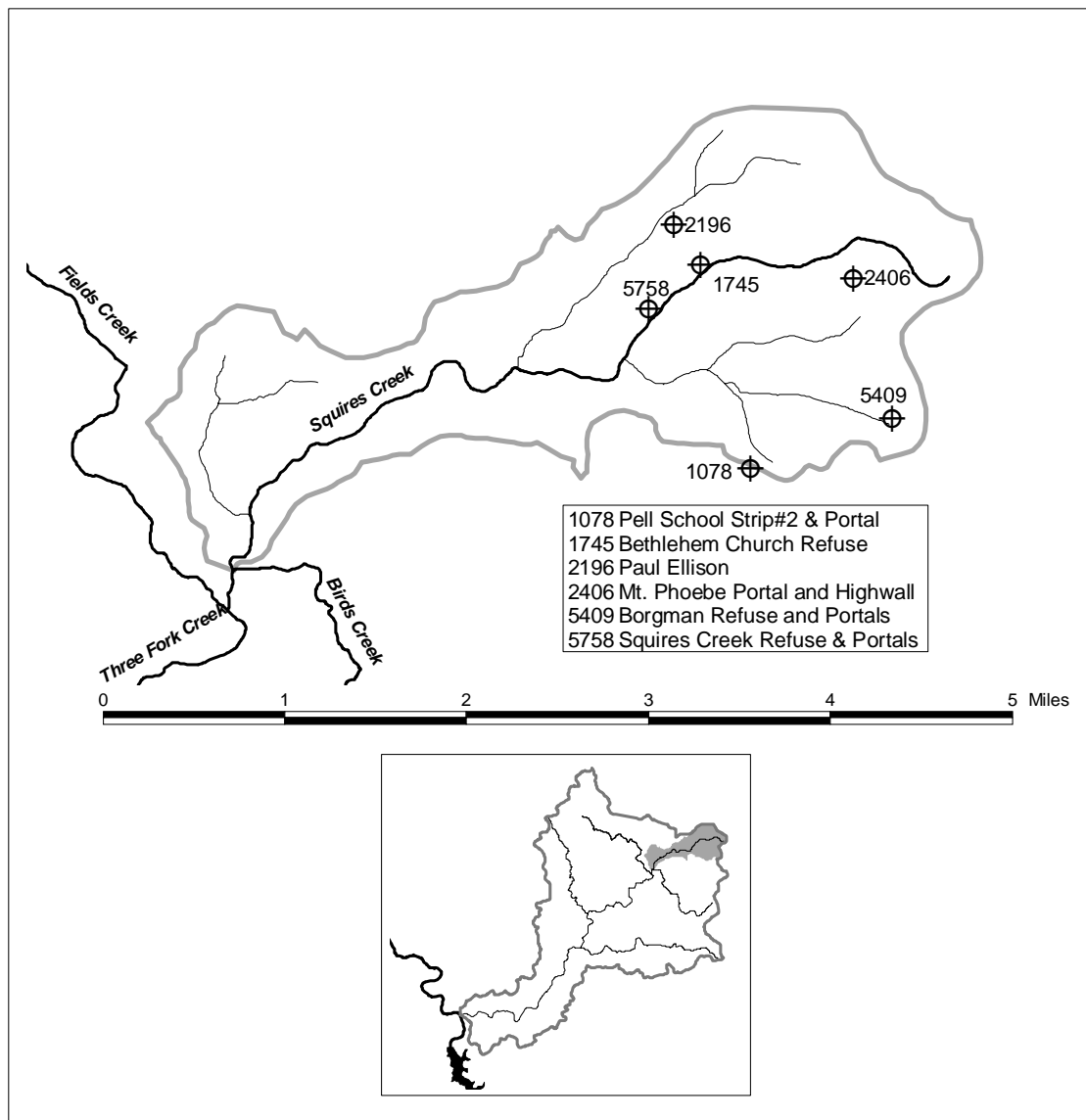
Site name (Problem area no.)	Past reclamation cost	Site and cost description	Estimated future cost for water remediation
Birds Creek #7 (1077)	\$0	A small amount of AMD flows from two portals. Reclamation of the area near those portals should generate enough alkalinity to neutralize the acidity.	\$50,000
Birds Creek #4 (1083)	\$0	A small amount of AMD flows from two portals. Reclamation of the area near those portals should generate enough alkalinity to neutralize the acidity.	\$80,000
Bird's Creek Portals (1085)	\$0	Four portals discharge AMD at a moderate rate, and some refuse coal must be reclaimed.	\$200,000
Howesville Portals (1743)	\$0	There is a portal discharging AMD, but neither chemical nor flow data are available.	No estimate possible
Hopewell Church Refuse and Drainage (1744)	\$0	There is a small AMD flow to treat passively and refuse coal to be reclaimed.	\$130,000
Hopewell Strip #2 (2414)	\$0	There is a small AMD flow to treat passively and refuse coal to be reclaimed.	\$100,000
Concord (Conley) Highwall (2919)	\$0	Refuse coal must be reclaimed.	\$20,000
Irish Ridge #2 (2920)	\$0	Problem area description (PAD) indicates that there is a discharge, but no flow or chemistry data are available	No estimate possible
Jessop Strip #1 (2984)	\$0	There is a small AMD flow of 2 gpm, but no chemistry data.	No estimate possible
Jessop Portal & Highwall (3362)	\$0	Seven portals are discharging AMD that requires treatment.	\$520,000
Shaffer Strip (3454)	\$0	There is a small AMD flow to treat passively and refuse coal to be reclaimed.	\$80,000
Total, Birds Creek watershed			>\$1,180,000

Source: Past reclamation costs from OSM (2005a). Site and cost descriptions from OSM (2005a) and WVDEP (Various dates). Estimated future costs for water remediation calculated in this plan.

5.6 Squires Creek

Squires Creek (WVMT-12-I) includes TMDL subwatersheds 7, 8, 10, 12, and 18.

Figure 7: Abandoned mine lands in the Squires Creek watershed



Note: Symbols are located at coordinates given by the AMLIS database. AMLs usually encompass surrounding areas.

Table 12: Costs and descriptions of abandoned mine lands in the Squires Creek watershed

Site name (Problem area no.)	Past reclamation cost	Site and cost description	Estimated future cost for water remediation
Pell School Strip #2 & Portal (1078)	\$481,194	Previous work at this site did not address the water pollution complaint, but no chemistry or flow data are available to evaluate the site.	\$210,000
Bethlehem Church Refuse (1745)	Unknown	35 acres of refuse were reclaimed at this site, but approximately one acre of refuse still requires reclamation.	\$10,000
Paul Ellison (2196)	\$0	AMD flows from six auger holes, which should be sealed like portals, and the AMD treated with passive methods. Refuse coal, in an area assumed similar to that of the bench, must be reclaimed.	\$400,000
Mt. Phoebe Portal and Highwall (2406)	\$0	AMD from a single portal must be treated.	\$540,000
Borgman Refuse and Portals (5409)	\$0	Water is discharging from a portal at site 3, and must be treated. There is also refuse coal to be reclaimed.	>\$1,000,000
Squires Creek Refuse & Portals (5758)	\$0	AMD has gathered in front of portals, but was not flowing. Use reclamation to make sure that any small amount of water flowing does not become acidic through interaction with pyritic material.	\$100,000
Total, Squires Creek watershed			>\$2,260,000

Source: Past reclamation costs from OSM (2005a). Site and cost descriptions from OSM (2005a) and WVDEP (Various dates). Estimated future costs for water remediation calculated in this plan.

5.7 Streams not listed as impaired

Streams not listed as impaired, but which still have AMLs discharging AMD, include Little Laurel Run, Cooks Run, and Fields Creek. Little Laurel Run (MT-12-B) includes TMDL subwatershed 78, Cooks Run (MT-12-C-1) includes TMDL subwatershed 62, and Fields Creek (MT-12-G) includes TMDL subwatershed 5.

Figure 8: Abandoned mine lands in subwatersheds not listed as impaired

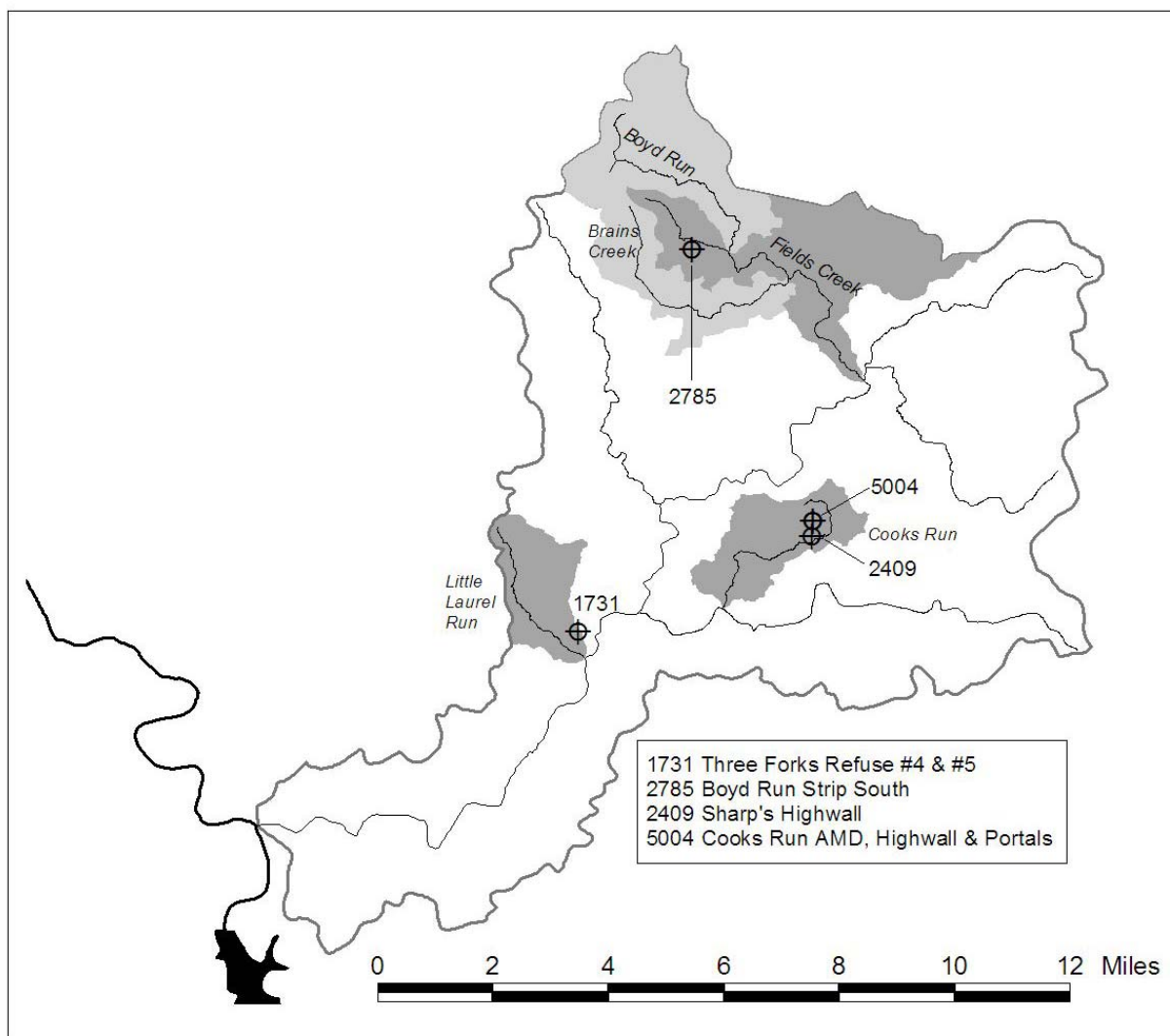


Table 13: Costs and descriptions of abandoned mine lands in subwatersheds not listed as impaired

Site name (Problem area no.)	Past reclamation cost	Site and cost description	Estimated future cost for water remediation
<u>Little Laurel Run</u> Three Forks Refuse #4 & #5 (1731)	\$0	A small area of refuse coal must be reclaimed.	\$30,000
<u>Cooks Run</u> Sharp's Highwall (2409)	\$0	Water pools on some of the mined area, which includes spoil piles. Reclaim the site to make sure water does not interact with acidic materials.	\$30,000
Cooks Run AMD, Highwall & Portals (5004)	\$0	There are three collapse portals discharging AMD. The site requires wet seals, OLCs and RAPSS.	\$280,000
<u>Fields Creek</u> Boyd Run Strip South (2785)	\$0	Site actually drains to Fields Creek rather than Boyd Run. Refuse coal must be reclaimed.	\$150,000
Total, Subwatersheds not listed as impaired			\$490,000

Source: Past reclamation costs from OSM (2005a). Site and cost descriptions from OSM (2005a) and WVDEP (Various dates). Estimated future costs for water remediation calculated in this plan.

6. TECHNICAL AND FINANCIAL ASSISTANCE

A combination of federal and state agencies, academic institutions, watershed organizations, consultants, and citizens will be involved in providing technical and financial assistance for Three Fork watershed projects.

The technical and financial assistance chapter focuses on AMD only. If other sources of impairment are identified in the watershed this section will be updated to include other sources of technical and financial assistance to address those issues.

6.1 Technical Assistance Providers

Technical assistance is needed for the following tasks:

- coordinating and applying for the various funding sources;
- collecting data at AMD sources in preparation for the design of remediation projects;
- creating conceptual designs of remediation projects;
- creating detailed engineering designs of remediation projects;
- performing project management, including putting projects out for bid, managing projects, and tracking their progress; and
- monitoring instream and source water quality following the installation of remediation projects to document their effectiveness.

6.1.1 *West Virginia Department of Environmental Protection*

Two WVDEP divisions will provide technical assistance. The Division of Water and Waste Management monitors the water quality of the watershed through its Watershed Assessment Program and its pre-TMDL monitoring program (WVDEP, 2005a). This division also provides technical assistance for the use of best management practices, educates the public and land users on nonpoint source issues, enforces water quality laws that affect nonpoint sources, and restores impaired watersheds through its Non-Point Source Program (WVDEP, 2005b).

WVDEP's Office of Abandoned Mine Lands and Reclamation (OAMLR) directs technical resources to watersheds to address AMLs. Through their Stream Restoration Group (SRG), the office conducts extensive source monitoring of AMLs—as well as instream monitoring—before remediation systems are designed.

6.1.2 *Office of Surface Mining, Reclamation and Enforcement*

OSM provides technical assistance by sharing their knowledge and experience in designing and financing AML remediation projects.

6.1.3 *West Virginia University*

A number of the colleges and individuals at West Virginia University may provide assistance for projects in the watershed. The National Mine Land Reclamation Center (NMLRC), housed at the university, has experience providing conceptual site designs for reclamation projects and monitoring water quality produced by AMLs before and after projects are installed. NMLRC is dedicated to developing innovative AMD treatment technologies. Technical assistance may also be provided by departments within the university with expertise in fisheries and wildlife resources, mine land reclamation, and water quality improvement.

6.1.4 Other technical assistance providers

Other agencies and organizations may also provide technical assistance. Natural Resources Conservation Service (NRCS) engineers have designed AMD remediation projects in some West Virginia watersheds and may be available for assistance. Local conservation districts may also be a repository of information and assistance. In addition, USEPA staff with expertise in AMD from Region 3 and from headquarters may provide technical assistance.

6.2 Funding Sources

Several funding sources are available for nonpoint source AMD remediation on AMLs and for water quality monitoring, including:

- Section 319 funds,
- the Abandoned Mine Land Trust Fund,
- the 10% AMD Set-Aside Fund,
- Watershed Cooperative Agreement Program grants,
- Stream Partners Program grants,
- Brownfields grants,
- other government funding sources, and
- private foundation grants.

These funding sources are described in turn below.

6.2.1 Section 319 funds

Clean Water Act Section 319 funds may be provided by USEPA to WVDEP to be used for reclamation of nonpoint source AMD sources. This Watershed Based Plan is being developed so that these funds can be allocated to the Three Fork watershed. WVDEP's Division of Water Resources Non-Point Source Program sets priorities and administers the state Section 319 program (WVDEP, 2005b).

6.2.2 The Abandoned Mine Land Trust Fund

Before 1977, when the Surface Mining Control and Reclamation Act was enacted, coal mines generally did not manage acid-producing material to prevent AMD or treat the AMD that was produced. These "pre-law" mines continue to be significant AMD sources and are treated as nonpoint sources under the Clean Water Act.

To reclaim these AMLs, the Act established the AML Trust Fund. This fund, supported by a per-ton tax on mined coal, has been allocated to coal mining states for remediation projects, according to a formula that takes states' current coal production into account. Authorization for this tax expired and has been temporarily extended, and if a permanent reauthorization is not secured, this very important source of funding for AMD remediation may be lost.¹

For many reasons, the AML Trust Fund has failed to address AMD at a rapid pace:

- The priorities for disbursed monies place health and safety hazards ahead of water quality issues.
- Even though OSM allows states to assign water quality problems a priority equal to that of potential health and safety problems, WVDEP has been slow to change its priorities accordingly.

¹ Reauthorization of the AML Trust Fund, which expired on September 30, 2004, is still not settled. At the time that this document is being written, the fund has been temporarily reauthorized through June 2006. A new OSM rule published in September 2004 also reauthorizes a much smaller per-ton tax. It is still not clear what shape a final reauthorization might take.

- Only part of the AML Trust Fund's income is disbursed each year, so that less money is available for remediation than the legislation initially envisioned.
- Some of the money that is disbursed from interest generated by the fund pays for health benefits for former miners.
- At least half of the AML fees collected in each state are allocated back to the state of origin, and are not available for AML reclamation in other states; therefore, much of the AML monies are earmarked for states with few AML problems.
- Some of the money allocated to West Virginia from the AML Trust Fund is used for water-line extensions, because deep mines are responsible for the failure of a number of private wells.
- Funds that are sent back to West Virginia are spent on agency staff salaries in addition to on-the-ground remediation.

Still, WVDEP has funded many AMD remediation projects on AMLs. But these projects are typically not designed to meet stringent water quality goals like those set out in this Watershed Based Plan. The agency typically uses a small number of cost-effective techniques, such as open limestone channels, and chooses the layout for these measures based on how much land is available (for example, the distance between a mine portal and the boundary of properties for which the agency has right-of-entry agreements).

Unless significantly more money were allocated to West Virginia's AML program and these augmented funds were spent on water quality problems, the AML Trust Fund will not be sufficient to implement the AMD pollutant reductions shown in Table 6 in the foreseeable future. And if the fund is not reauthorized, this important source of funding may disappear completely. OAMLR administers West Virginia's use of AML Trust Fund grants.

6.2.3 10% AMD Set-Aside Fund

The 10% AMD Set-Aside Program allows states to reserve up to 10% of their annual AML Trust Fund allocations as an endowment for use on water quality projects. These funds are critically important, because while regular AML Trust Fund allocations can only be spent on capital costs, 10% AMD Set-Aside Fund allocations can be spent on operations and maintenance.

As of March 14, 2005, \$14.7 million remains in the West Virginia Set-Aside Fund (Darnell, 2005). The agency typically only spends the interest; therefore, the amount available for AMD projects varies with interest rates. In fiscal year 2001 the fund had the highest amount of interest available: \$760 thousand. As of fiscal year 2003 the interest available has fallen to \$211 thousand, and in subsequent years interest has fallen even further (Darnell, 2005). Long term commitments have been made to fund operations and maintenance on many AML projects across the state. If WVDEP continues to add money to this fund and if interest rates increase, funds may be available for projects in the Three Fork watershed.

These funds cannot be allocated to a watershed until after a Hydrologic Unit Plan is developed and approved by OSM. A new Hydrologic Unit Plan will be needed for the Three Fork watershed.

6.2.4 Watershed Cooperative Agreement Program

Grants specifically for AMD remediation projects on AMLs are available through OSM's Watershed Cooperative Agreement Program (WCAP). The WCAP is part of the Appalachian Clean Streams Initiative. Grants of up to \$100,000 are awarded to not-for-profit organizations that have developed cooperative agreements with other entities to reclaim AML sites (OSM, 2004). A match is required to receive these grants and is typically met with Section 319 funds.

6.2.5 *Stream Partners Program*

This program offers grants of up to \$5,000 to watershed organizations in West Virginia. Grants can be used for range of projects including small watershed assessments, water quality monitoring, public education, stream restoration, and organizational development. Stream Partners may be pursued in the future to compliment nonpoint source research, education, and reclamation projects in the watershed.

6.2.6 *Brownfields grants*

Brownfields grants of up to \$200 thousand are available through a competitive process; these grants can be applied to mine scarred lands. Competitive site assessment grants can be used for inventory, planning, quantification of environmental risks, and development of risk management or remedial action plans. Competitive remediation grants can then be used to build treatment systems.

6.2.7 *Other government funding sources*

NRCS is funding AMD remediation in the Deckers Creek watershed in north-central West Virginia through a Public Law-566 watershed restoration project. USACE has funded an AMD study and is planning to fund AMD remediation work in the lower Cheat watershed. Pending successful outcomes of these projects, these federal agencies might be potential funders for AMD remediation in the Three Fork watershed.

7. IMPLEMENTATION SCHEDULE, MILESTONES AND MEASURABLE GOALS

Significant AMD pollutant reductions are still needed in the Three Fork watershed. Because of the uncertainty of securing the required funds from a variety of agencies in a short period of time, the schedule, milestones, and measurable goals are divided into five-year phases and no final end date is projected for implementing all of the reductions in this Watershed Based Plan.

Some details are provided for Phase 1, which lasts from 2006 through 2010, because cleanup efforts have recently started. The schedule, milestones, and goals are designed to expand upon these existing efforts. Far fewer details are given for Phase 2, because of the difficulty of predicting how many remediation projects will be funded.

7.1 Phase 1: 2006 through 2010

The broad goals for AMD remediation in Phase 1 are to collect data, plan and coordinate activities among agencies and organizations, secure funding for remediation projects, construct new projects, and maintain existing projects.

7.1.1 *Collect data*

- **Monitor streams for AMD pollutants.** Save the Tygart has collected instream monitoring data since January 2004; these data are sufficient to start the planning process at this time. New instream data will be collected over time to help guide the process in the future and to gage progress toward meeting the goals of this plan.
- **Monitor reclaimed AML sites.** Monitoring at reclaimed sites will be used to develop operations and maintenance plans and to characterize additional treatment needs at sites that were not adequately addressed during past reclamation.
- **Monitor unreclaimed AML sites.** Monitoring will also occur at sites that have not been reclaimed, as described in the following chapter. Data will be used to design appropriate treatment systems.

7.1.2 *Plan and coordinate activities*

- **Set watershed restoration priorities.** Although a formal priority system is not yet in place, Save the Tygart tentatively plans to focus its first restoration efforts on smaller tributaries that can benefit the most from AMD remediation. Save the Tygart will work with partners to develop a formal priority system.
- **Develop a Hydrologic Unit Plan.** A Hydrologic Unit Plan is required so that the Set-Aside Fund can be used to pay for operations and maintenance of sites in the Three Fork watershed.
- **Develop plans for new and improved reclamation projects.** Save the Tygart and partners will agree on plans to install new and to improve existing reclamation projects in the watershed.
- **Develop operations and maintenance plans.** Once the Hydrologic Unit Plan is completed, Save the Tygart and partners will develop operations and maintenance plans for AML sites where reclamation has succeeded. These plans will be coordinated with OAMLRL's plans for using the Set-Aside Fund.
- **Reassess the big picture.** At the end of this five-year period, Save the Tygart and partners will reassess the strategic priorities for AMD remediation in the watershed. This assessment will be used to track improvements over time and to help plan remediation and operations and maintenance priorities for the next five-year period.

7.1.3 *Secure funding*

- **Secure funds for reclamation projects.** Each year, Save the Tygart and partners will secure funds to pay capital costs from the 319 program, the AML Trust Fund, and the OSM WCAP.
- **Secure funds for operations and maintenance.** Save the Tygart and partners will also ensure that sufficient operations and maintenance funds are spent from the Set-Aside Fund and other potential sources to keep all projects in the watershed functioning properly.
- **Investigate other funding sources.** NRCS Public Law 566 and USACE funds will also be investigated.

7.1.4 *Install remediation projects*

- **Build new projects.** As funds are secured, new projects will be built. In the short term, Save the Tygart and partners are planning to address the West End Portals & Structure (470) site at the headwaters of Raccoon Creek.
- **Add water quality improvements to existing projects.** In many cases, OAMLRL designs and builds remediation projects with AML Trust Fund grants that do not wholly address AMD. Wherever possible, Save the Tygart and partners will add on to these remediation projects so that they directly address water quality.
- **Operate and maintain existing sites.** After Set-Aside funds are obtained, operations and maintenance will be performed on sites where necessary.

7.1.5 *Measurable goals for Phase 1*

By the end of Phase 1 in December 2010, the following measurable goals will be achieved:

- AMD remediation projects will have been installed on one AML per year, for a total of five AMLs in the Three Fork watershed. These projects will be functioning well enough so that water discharged from these sites meet technology-based effluent limitations for pH, iron, and manganese.
- Instream water chemistry measurements will show that the immediate receiving streams for these AMLs have improved with regard to pH, iron, manganese, and aluminum. Measurements in the Three Fork Creek mainstem will also show improvements.

7.2 **Phase 2: 2011 through 2015**

Phase 2 is described in less detail than Phase 1, because of the uncertainty in what will be finished by 2010. Even though it is a measurable goal for Phase 1 to complete reclamation on five sites, new information or problems in securing funding may make it necessary to continue this process in Phase 2. Save the Tygart and partners will undertake the same four categories of activities in Phase 2:

- Collect more data in receiving streams and on AML sites;
- Develop plans for new and improved reclamation projects and for operations and maintenance;
- Secure capital funds for new and improved reclamation projects, and ensure that sufficient operations and maintenance funds are available to meet the needs of the watershed;
- Build new and improved projects and operate and maintain existing sites.

8. MONITORING

Instream monitoring is important to gage the recovery of streams after remediation projects are installed, and is also crucial as partners engage in periodic planning of their reclamation priorities. Monitoring of AMD sources is also necessary to understand which sources are discharging how much pollution. These data are used to help decide on priorities, and are essential for the design of realistic treatment systems.

8.1 Instream monitoring

Several agencies and organizations are now monitoring the Three Fork watershed, and will continue to do so in the future.

8.1.1 *WVDEP Watershed Assessment Program*

According to WVDEP's five-year watershed management framework cycle, the agency performs in-depth monitoring of the state's watersheds every five years. The next monitoring year for the Three Fork watershed is scheduled to begin in 2007. These monitoring data will be helpful to show whether streams are improving or declining in quality. In addition to AMD water chemistry, technicians collect benthic macroinvertebrates to determine biological impairments and fecal coliform data to determine bacteria impairments. Technicians also perform sediment-related assessments. WVDEP will then use these data, plus data collected by other agencies and organizations, to make impairment decisions for the next 303(d) list.

8.1.2 *Save the Tygart*

Save the Tygart has collected monthly instream water quality data for the last year-and-a-half. The group plans to continue collecting these data in the future, and is looking for funding, volunteers, and expertise to expand their monitoring program in the future.

8.2 Source monitoring

8.2.1 *WVDEP Stream Restoration Group*

SRG, which works within OAMLR, collects source data when WVDEP is designing a remediation project. The only sampling that SRG is planning for the near future in the Three Fork watershed is at the headwaters of Squires Creek in conjunction with the Borgman Refuse and Portals (5409) site. All pre-construction sampling has been completed there, but quarterly sampling will resume upon completion of the project. Construction of this project is temporarily on hold (Vukovich, 2005).

8.2.2 *National Mine Land Reclamation Center*

In some situations, NMLRC has collected source data in anticipation of creating conceptual designs for treatment systems. When appropriate, it is anticipated that NMLRC will continue to play this valuable role.

8.2.3 *Save the Tygart*

Save the Tygart periodically collects data from AML discharges, and plans to collect data in the future given sufficient resources.

9. OUTREACH AND EDUCATION

9.1 Save the Tygart

Save the Tygart has undertaken a range of outreach and education activities, and plans to continue these activities as this plan is implemented. Outreach and education activities include:

- Submitting press releases to local newspapers and television stations so that information on AMD remediation topics can be broadcast to a wide audience;
- Printing and distributing brochures with background on Save the Tygart and their efforts to clean up AMD;
- Giving speeches to the Grafton Rotary and other organizations;
- Collaborating with science teachers at the Taylor County High School so that AMD remediation topics can be presented at school and so that students can volunteer for field work with Save the Tygart;
- Creating a large artistic rendering of the watershed and exhibiting it at schools and at meetings. The rendering will show water monitoring sampling points, local landmarks such as schools and churches, and will show three dimensional topography.
- Holding regularly scheduled monthly public meetings, at which members of the public can come and learn about Save the Tygart's efforts to remediate AMD on Three Fork Creek.

9.2 West Virginia Department of Environmental Protection

Prior to initiating its regular five-year monitoring effort in 2007, WVDEP will hold a public meeting in the watershed to gather suggestions for monitoring locations. WVDEP will include information at this meeting on the status of plans for remediating nonpoint source pollution in the watershed.

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APPENDIX A. ALL ABANDONED MINE LANDS IN THE THREE FORK WATERSHED

Many AMLs do not discharge polluted water. Table 3 in Chapter 3 lists those AMLs known to discharge AMD. Table 13 lists the sites in Table 3 plus all other sites that have been inventoried by WVDEP.

Although the PADs and other information available at OAMLR office suggest that many of these sites do not discharge AMD, they are included in this plan in case new data show otherwise.

Table 14: All abandoned mine lands in the Three Fork watershed

Problem area no.	Problem area name	Map	AM-LIS	PAD	Stream name	Stream code	TMDL subwatershed
470	West End Portals & Structures	Y	Y	Y	Raccoon	MT-12-C	58
471	Birds Creek Tipple	Y	Y	Y	Birds	MT-12-H	20
490	Snider Highwall	Y	Y	Y	Birds	MT-12-H	15
868	Birds Creek Drainage	Y	N	N	Birds	MT-12-H	19
899	Maple Run #1	Y	N	Y	Raccoon	MT-12-C	67
900	Maple Run Portals and AMD	Y	Y	Y	Raccoon	MT-12-C	67
982	Three Forks #2	Y	Y	Y	Three Fork	MT-12	66
983	Three Forks #3	Y	Y	Y	Three Fork	MT-12	66
989	Three Forks #1	Y	Y	Y	Rocky	MT-12-A	143
1054	Bird's Creek #3	N	Y	N	Birds	MT-12-H	37
1075	Birds Creek #8	Y	Y	Y	Birds	MT-12-H	19
1076	Birds Creek Tipple II	Y	N	Y	Birds	MT-12-H	41
1077	Birds Creek #7	Y	Y	Y	Birds	MT-12-H	19
1078	Pell School Strip #2 & Portal	N	Y	Y	Squires	MT-12-I	8
1079	St. Josephs School Gob	N	N	Y	Birds	MT-12-H	15
1083	Birds Creek #4	Y	Y	Y	Birds	MT-12-H	38
1085	Birds Creek Portals	Y	Y	Y	Birds	MT-12-H	19
1506	Jessop Strip #3	Y	Y	Y	Birds	MT-12-H	41
1547	West End #1	Y	Y	Y	Raccoon	MT-12-C	58
1548	Howesville Site	Y	Y	N	Birds	MT-12-H	41
1723	Irontown Refuse	Y	Y	Y	Three Fork	MT-12	79
1728	Raccoon Creek Refuse #2	Y	Y	Y	Raccoon	MT-12-C	67
1730	Boyd Run Strip East	Y	Y	Y	Fields	MT-12-G	5
1731	Three Forks Refuse #4 & #5	Y	Y	Y	Three Fork	MT-12	79
					Little Laurel	MT-12-B	78
1738	Austen Refuse	Y	Y	Y	Raccoon	MT-12-C	56
1739	Austen Refuse #2	Y	N	Y	Raccoon	MT-12-C	55
1741	Cooks Run Refuse	Y	N	Y	Raccoon	MT-12-C	54
1742	Cooks Run Portals	Y	N	Y	Cooks	MT-12-C-1	62
1743	Howesville Highwall	Y	Y	Y	Birds	MT-12-H	15
1744	Hopewell Church Refuse and Drainage	Y	Y	Y	Birds	MT-12-H	15
1745	Bethlehem Church Refuse	Y	Y	Y	Squires	MT-12-I	7
1746	Newburg Tipple and Refuse	Y	Y	Y	Raccoon	MT-12-C	64
1747	Lick Run Refuse	Y	N	Y	Lick Run	MT-12-F	27
1749	Squires Creek Refuse	Y	Y	Y	Squires	MT-12-I	18
1777	Browns Chapel Strips	Y	N	Y	Brains	MT-12-G-2	11
1796	Boyd Run Refuse	Y	Y	Y	Boyd	MT-12-G-3	2
2190	Donnie Thorn Highwall	Y	Y	Y	Birds	MT-12-H	16
2193	Kerns Highwall	Y	Y	Y	Fields	MT-12-G	5
2196	Paul Ellison	Y	Y	Y	Squires	MT-12-I	10
2226	N. WV Railroad Highwall	Y	Y	Y	Birds	MT-12-H	15
2351	Summers	Y	N	Y	Brains	MT-12-G-2	11
2406	Mt. Phoebe Portal and Highwall	Y	Y	Y	Squires	MT-12-I	7

(Continued on following page)

Table 14: All abandoned mine lands in the Three Fork watershed (continued)

Problem area no.	Problem area name	Map	AM-LIS	PAD	Stream name	Stream code	TMDL subwatershed
2408	Miller Highwall	Y	Y	Y	Birds	MT-12-H	40
2409	Sharp's Highwall	Y	Y	Y	Cooks Run	MT-12-C-1	62
2410	Austen Highwall #2	Y	Y	Y	Raccoon	MT-12-C	56
2411	Austen Highwall #3	Y	Y	Y	Raccoon	MT-12-C	56
2413	West End #2	Y	Y	Y	Raccoon	MT-12-C	57
2414	Hopewell Strip #2	Y	Y	Y	Birds	MT-12-H	16
2415	Pell School Strip #2	Y	N	Y	Squires	MT-12-I	18
2416	Spiker Highwall	Y	Y	Y	Birds	MT-12-H	15
2768	Brown Chapel Highwall	Y	N	N	Brains	MT-12-G-2	11
2769	Browns Chapel Highwall	Y	N	Y	Fields	MT-12-G	5
2785	Boyd Run Strip South	Y	Y	Y	Fields	MT-12-G	5
2786	Boyd Run Strip West	Y	Y	Y	Fields	MT-12-G	5
2818	Hardman Highwall	N	Y	Y	Raccoon	MT-12-C	67
2819	Raccoon Creek Highwall	Y	Y	Y	Raccoon	MT-12-C	67
2844	Three Forks Creek Watershed	Y	Y	Y	Three Fork	MT-12	All
2898	Hardman Highwall	Y	N	N	Raccoon	MT-12-C	67
2917	Irish Ridge #1	Y	Y	Y	Birds	MT-12-H	19
2919	Concord (Conley) Highwall	Y	Y	Y	Birds	MT-12-H	37
2920	Irish Ridge #2	Y	Y	Y	Birds	MT-12-H	16
2984	Jessop Strip #1	Y	Y	Y	Birds	MT-12-H	41
3362	Jessop Portal & Highwall	N	Y	Y	Birds	MT-12-H	41
3364	Weaver Slide	Y	Y	Y	Birds	MT-12-H	41
3366	Knott's Strip #2	Y	Y	Y	Birds	MT-12-H	37
3367	Plum Heirs Highwall	Y	N	Y	Birds	MT-12-H	37
3371	Concord Cemetary Highwall	Y	Y	Y	Raccoon	MT-12-C	54
3453	Hopewell Church Highwall	N	Y	N	Birds	MT-12-H	Unknown
3454	Shaffer Strip	Y	Y	Y	Birds	MT-12-H	41
3547	Knotts Strip #1	Y	Y	Y	Raccoon	MT-12-C	54, 56
					Birds	MT-12-H	37
3548	Raccoon Creek Highwall	Y	Y	Y	Raccoon	MT-12-C	55
4340	Birds Creek Refuse	Y	Y	Y	Birds	MT-12-H	37
4641	Raccoon Creek Mine Blowout	N	Y	Y	Raccoon	MT-12-C	56
4971	Raccoon Creek Refuse and Coke Ovens	Y	Y	Y	Raccoon	MT-12-C	56
5004	Cooks Run AMD, Highwall & Portals	Y	Y	Y	Cooks	MT-12-C-1	62
5240	Raccoon Creek (Pyles) Highwall	Y	Y	Y	Raccoon	MT-12-C	56
5409	Borgman Refuse And Portals	N	Y	N	Squires	MT-12-I	7
5614	St. Joseph (Price) Subsidence	N	Y	Y	Squires	MT-12-I	8
5758	Squires Creek Refuse & Portals	N	Y	Y	Squires	MT-12-I	7
6072	Gladesville Road Portal	N	Y	N	Brains	MT-12-G-2	11

Source: OSM (2005a) and WVDEP (Various dates). Map column refers to the mylar maps available from the WVDEP. Maps depict location of many AML sites, but not all. AMLIS column indicates whether or not problem area is included in the AMLIS database. PAD column indicates whether or not a PAD has been located for this site within the WVDEP files.

APPENDIX B. LOAD CALCULATIONS FOR AMLS WITH WATER QUALITY PROBLEMS

Few measurements are available for determining pollutant loads from AMLs and other sources of AMD. Measurements include those given in PADs, measurements of loads in streams made by SRG, a few additional measurements made in conjunction with a USACE study, and measurements made by Save the Tygart. These measurements, however, still do not estimate loads for subwatersheds or AMLs. Although SRG made four rounds of measurements in the Three Fork watershed, concentrations of metals were measured in only one of the sweeps. Save the Tygart had no way to measure stream flow for about one year of its measurements.

Load calculations, therefore, depend on the observations, measurements and estimates of WVDEP personnel who wrote the PADs. When describing water problems, PADs often include an estimate of the flow in gallons per minute (gpm), a pH measurement, and occasionally a determination of total iron concentration, using a method that only measures up to 10 mg/L.

Such measurements were converted to loads according to the following assumptions. First, the observed flow was accurate and was close to the annual average flow. Second, the chemical characteristics of the AMD samples in the Three Fork watershed are similar to those found in the lower Cheat River watershed. Two facts support the assumption: Mines in the Upper Freeport coal seam have produced most of the AMD in both watersheds, and the two areas are contiguous. Third, there are reasonably close relationship between acidity and metals concentrations.

We therefore used regressions between pH and acidity and between acidity and metals concentrations from samples in the Cheat River watershed to estimate acidity in waters from the Three Fork watershed. The regression equation for the relationship between acidity and pH is:

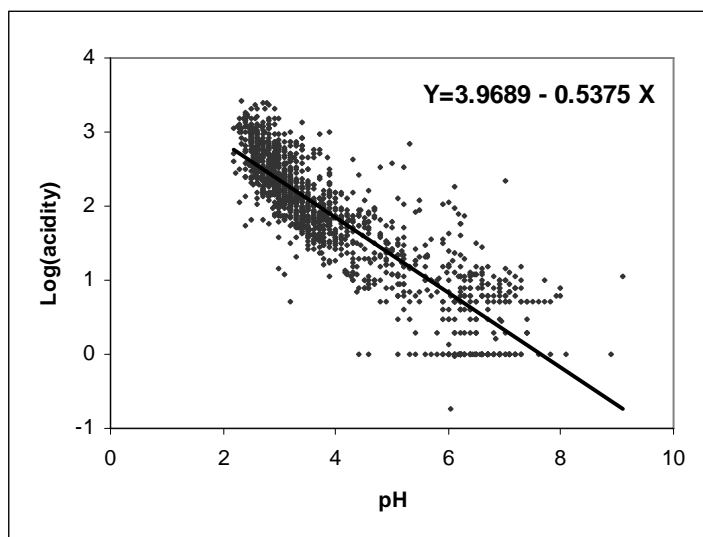
$$\log(\text{acidity}) = 3.9689 - 0.5375 * \text{pH}$$

or

$$\text{acidity} = 10^{(3.9689 - 0.5375 * \text{pH})}$$

Where acidity is expressed as mg/L of CaCO_3 . Figure 9 contains the data from which the relationship was derived.

Figure 9: Relationship between pH values and acidity in samples of AMD from the lower Cheat watershed



Source: Pavlick et al. (2005).

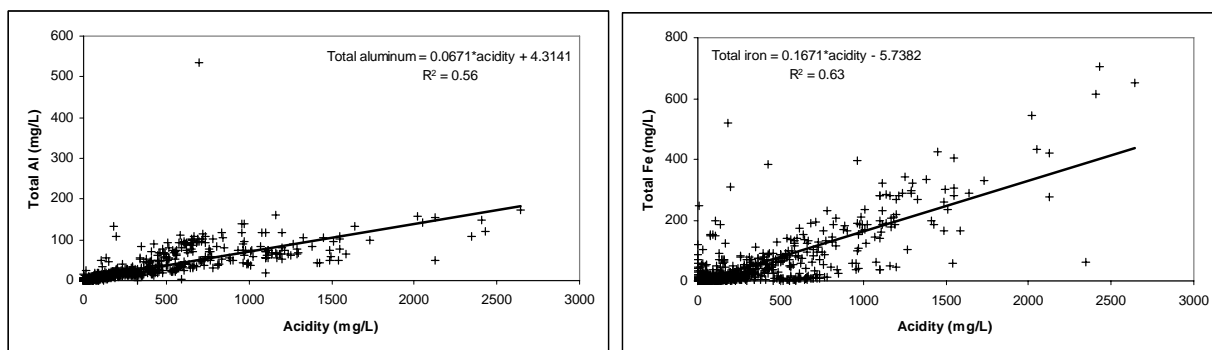
Concentrations of Al and Fe were related to acidity in AMD from the lower Cheat according to the following equations:

$$\text{Al} = 0.0671 * \text{acidity} + 4.3141$$

$$\text{Fe} = 0.1671 * \text{acidity} - 5.7382$$

The data for these regressions appear in Figure 10. No relationship was found between acidity and Mn in AMD samples from the Cheat watershed. Where there are no measurements, therefore, Mn concentration is set at the average value of 3.4 mg/L.

Figure 10: Relationship between acidity and concentrations of Al and Fe in samples of AMD from the lower Cheat watershed



Source: Pavlick et al. (2005).

When measurements of Al, Fe, and Mn were available for AMD in the Three Fork watershed, those values were preferred over those determined by the regressions. Load calculations for abandoned mine lands with sufficient data are shown in Table 15.

Table 15: Load calculations for abandoned mine lands with sufficient data

Problem area name (Problem area number)	Avg. flow (gpm)	pH	Acidity (mg/L)	Method	Al	Fe	Mn
Direct drains to Three Fork Creek	<i>Insufficient data for load calculations</i>						
Raccoon Creek							
West End Portals & Structures (470)	15	2.7	247	Acidity, Fe measured, Al, Mn from regression	1,375	1,060	224
Maple Run Portals & AMD (900)	50	2.8	291	Regression	5,233	9,414	746
West End #1 (1547)	338	3.35	147	Regression	21,068	28,013	5,045
Austen Refuse (1738)	3	2.9	257	Regression	284	490	45
Austen Highwall #3, Refuse (2411)	400	3.1	201	Regression	31,227	48,826	5,970
Knotts Strip #1 (3547)	10	4.3	45	Regression	323	82	149
			Total		59,511	87,884	12,179
Brains Creek	<i>Insufficient data for load calculations</i>						
Birds Creek							
Bird's Creek Portals (1085)	30	3.2	177	Regression	2,136	3,148	448
Hopewell Church Refuse and Drainage (1744)	10	4.6	31	Regression	282	132	149
Hopewell Strip #2 (2414)	5	2.7	329	Regression	580	1082	75
Jeesop Portal & Highwall (3362)	99	3.41	134	Regression	5,782	7,237	1,478
Shaffer Strip (3454)	10	3.5	137	Acidity, Fe measured, Al, Mn from regression	593	176	149
			Total		9,372	11,775	2,298
Squires Creek							
Pell School Strip #2 & Portal (1078)	75	4	66	Regression	2,876	1,736	1,119
Paul Ellison (2196)	85	4	66	Regression	3,260	1,968	1,269
Mt. Phoebe Portal and Highwall (2406)	50	2.6	373	Regression	6,436	12,411	746
Borgman Refuse and Portals (5409)	225	2.7	318	Regression	25,336	46,816	3,358
			Total		37,909	62,932	6,492
<u>STREAMS NOT LISTED AS IMPAIRED</u>							
Little Laurel Run	<i>Insufficient data for load calculations</i>						
Cooks Run							
Cooks Run AMD, Highwall & Portals (5004)	15	2.7	583	Acidity, Fe measured, Al, Mn from regression	2,860	4,965	224
			Total		2,860	4,965	224
Fields Creek	<i>Insufficient data for load calculations</i>						

APPENDIX C. COST CALCULATIONS FOR AMLS WITH WATER QUALITY PROBLEMS

Costs for eliminating AMD from each AML are usually sums of six components:

1. Construction of a RAPS,
2. Construction of an MRB,
3. Reclamation of acres of acid producing material,
4. Construction of mine seals,
5. Construction of OLCs, and
6. Engineering and project management costs.

In some cases, however, reclamation has taken place, and OLCs and wet seals have been installed.

Costs are rounded to nearest \$10 thousand to reflect the precision of the method used to estimate costs. When the cost for a site is calculated to exceed \$1 million, it is recorded as “>\$1,000,000.” This is done because data used for cost calculations, as already noted, are often so sparse as to make the calculations imprecise. This method ensures that estimates based on questionable data do not make the results too unreliable. A ceiling for passive treatment by RAPS has been set for several reasons. First, larger systems become more difficult to maintain. Poorly maintained systems are likely to experience uneven flows, and water may short circuit the system and emerge without being fully treated. In addition, the risks of failure with RAPS are not completely predictable, and the losses should an expensive RAPS fail is too great. Finally, as treatment sums start to number in the millions, it becomes possible to consider financing long-term, active treatment.

Decisions about the sizing of AMD treatment measures and the amounts of reclamation and of OLCs were chosen using the rules detailed below. Various exceptions to these rules are noted for individual sites, as described in Table 12.

C.1 Reducing and alkalinity producing systems

RAPSs were included whenever flows of AMD were identified and quantified. If site descriptions suggested that AMD came only from surface materials, the cost of a RAPS was not included. When appropriate AMD sources were present, a RAPS was sized according to two parameters: design flow and acidity, using the “Vertical Flow Pond” module in the computer program AMDTreat (OSM, 2005b). This module allows a number of sizing methods. The one chosen was “Vertical Flow Pond based on Alkalinity Generation Rate.” The default alkalinity generation rate, $25 \text{ g m}^{-2} \text{ day}^{-1}$ (as CaCO_3) was used. Conditions for cost determination included:

- No liner for the system,
- No clearing and grubbing, and
- Standard piping costs.

In its help section, AMDTreat suggests that a RAPS should be sized according to “design flow,” or “the maximum flow that the treatment system is expected to handle.” Determination of a true design flow would require a large number of flow measurements taken under a variety of flow conditions. The only flow measurement available was a single, visual estimate by WVDEP inspector. The design flows chosen were double these estimates. Acidity values were either taken from the PADs or were calculated using the regression described in Appendix B.

Absence of any flow information prevented estimation of a cost for a RAPS.

C.2 Manganese removal beds

MRBs are sized using AMDTreat's default parameters for a 24 hour retention time. Cost of an MRB was calculated for only one site. Other sites had Mn levels that would not violate in-stream water quality standards

C.3 Land reclamation

Land reclamation costs were calculated at \$10,000 per acre. The acreage chosen was that of refuse coal described in the PAD. If spoil was mentioned at a highwall but no acreage was supplied, the area that would be filled in highwall reclamation was used as an area estimate. This "footprint" was calculated as the length of the highwall times twice its height. When stagnant AMD was found in portals, the reclamation needed to prevent that water from being acidic as it left the site was one acre per portal.

C.4 Mine seals

Where mine seals were not already constructed, the cost of \$5,000/seal was used (Bess, 2004). This cost was also used for auger holes that were discharging AMD.

C.5 Oxic limestone channels

The price of constructing OLCs was set at \$35/linear foot (Bess, 2004). The required length was estimated as 100 feet for each wet seal, and 100 feet for each acre of reclamation.

C.6 Engineering and project management costs

A 10% amount to be paid for the costs of developing blueprints and a 10% cost to pay for project management, including putting the project out for bid and inspecting the work as it takes place, have also been added to the costs.

Table 16: Cost calculations for each abandoned mine land that discharges acid mine drainage

Site name (Problem area no.)	Summary	Avg flow (gpm)	Design flow (gpm)	pH	Acidity (mg/L)	RAPS cost	Portal seals	Recl. area (acres)	OLC (ft)	MRB cost	Total const. cost	Engineering & project management	Grand total (Rounded)
Direct drains to Three Fork Creek													
Three Forks #2 (982)	Reclaim 4 acres and seal 4 portals						4	4	800		\$88,000	\$17,600	\$110,000
Three Forks #3 (983)	Reclaim 2 acres gob							2	200		\$27,000	\$5,400	\$30,000
Irontown Refuse (1723)	Reclaim a little gob							1	100		\$13,500	\$2,700	\$20,000
Raccoon Creek													
West End Portals & Structures (470)	Reclamation is done, must fix AMD from portals	15	30	2.7	247	\$84,111	0	0	0	\$13,395	\$97,506	\$19,501	\$120,000
Maple Run Portals & AMD (900)	Fix AMD from portals	50	100	2.8	291	\$312,139	6		600	\$44,652	\$407,791	\$81,558	\$490,000
West End #1 (1547)	This complaint and the costs for its remediation is included under PA 2411.												See 2411
Raccoon Creek Refuse #2 (1728)	Reclaim a little gob							1	100		\$13,500	\$2,700	\$20,000
Austen Refuse (1738)	Address small flow, take care of refuse	3	5	2.9	257	\$16,964	1	4	500	\$2,232	\$81,696	\$16,339	\$100,000
Cooks Run Refuse (1741)	Address refuse							15	1500		\$202,500	\$40,500	\$240,000
Newburg Tipple and Refuse (1746)	Reclaim 3 acres							3	300		\$40,500	\$8,100	\$50,000
Austen Highwall #2 (2410)	Reclaim slurry area							7	700		\$94,500	\$18,900	\$110,000
Austen Highwall #3, Refuse (2411)	Assume land work is done but water pollution complaint in AMLIS has no completed costs: portals must be addressed	400	800	3.1	201	\$1,671,187	0	0	0	\$357,212	\$2,028,399	\$405,680	\$2,430,000
Knotts Strip #1 (3547)	Reclaim bench and treat water	10	20	4.3	45	\$12,630	0	10	1000	\$8,930	\$156,560	\$31,312	\$190,000
Raccoon Creek Highwall (3548)	Reclaim bench							3	300		\$40,500	\$8,100	\$50,000
Raccoon Creek Refuse and Coke Ovens (4971)	Reclaim spoil							4	400		\$54,000	\$10,800	\$60,000
Brains Creek													
Browns Chapel Strips (1777)	Lots of refuse. Apparently sparse over 50 acres							50	5000		\$675,000	\$135,000	\$810,000
Summers (2351)	AMD coming from ground, nothing but reclaim							3	300		\$40,500	\$8,100	\$50,000

Site name (Problem area no.)	Summary	Avg flow (gpm)	Design flow (gpm)	pH	Acidity (mg/L)	RAPS cost	Portal seals	Recl. area (acres)	OLC (ft)	MRB cost	Total const. cost	Engineering & project management	Grand total (Rounded)
Birds Creek													
Birds Creek #7 (1077)	Reclaim two acres and two portals to make sure water does not become acidic.						2	2	400		\$44,000	\$8,800	\$50,000
Birds Creek #4 (1083)	Reclaim, get enough alkalinity to be sure about the water						3	3	600		\$66,000	\$13,200	\$80,000
Bird's Creek Portals(1085)	Moderate flows, chemistry iffy	30	60	3.2	177	\$118,562	4	1	500		\$166,062	\$33,212	\$200,000
Howesville Portals (1743)	No estimate possible												
Hopewell Church Refuse and Drainage (1744)	address small flows and refuse	10	20	4.6	31	\$9,237	5	4	900		\$105,737	\$21,147	\$130,000
Hopewell Strip #2 (2414)	Reclaim gob and treat water	5	10	2.7	329	\$39,588	1	2	300	\$4,465	\$79,553	\$15,911	\$100,000
Concord (Conley) Highwall (2919)	Reclaim spoil							1	100		\$13,500	\$2,700	\$20,000
Irish Ridge #2 (2920)	No estimate possible												
Jessop Strip #1 (2984)	No estimate possible												
Jessop Portal & Highwall (3362)	Treat water from 7 portals	99	198	3.41	134	\$284,979	7		700	\$88,410	\$432,889	\$86,578	\$520,000
Shaffer Strip (3454)	Reclaim bench and treat water	10	20	3.5	137	\$33,471	1	1	200	\$8,930	\$64,401	\$12,880	\$80,000
Squires Creek													
Pell School Strip #2 & Portal (1078)	Site was reclaimed, but water quality complaint was not addressed. A large discharge of AMD from a three portals must be addressed.	75	150	4	66	\$110,678				\$66,977	\$177,655	\$35,531	\$210,000
Bethlehem Church Refuse (1745)	Reclaim one acre							1	100		\$13,500	\$2,700	\$20,000
Paul Ellison (2196)	There is auger hole water and maybe spoil, but the new calculations are for reclaiming highwall. No specific area of spoil is known	85	170	4	66	\$124,492	5	7	1200	\$75,907	\$337,399	\$67,480	\$400,000
Mt. Phoebe Portal and Highwall (2406)	There is a portal here with a large, acidic flow.	50	100	2.6	373	\$397,582	1		100	\$44,652	\$450,734	\$90,147	\$540,000
Borgman Refuse and Portals (5409)	Treat water from portals at site 3 and reclaim spoil at all sites	225	450	2.7	318	\$1,489,098	4	4	800	\$200,932	\$1,778,030	\$355,606	\$2,130,000
Squires Creek Refuse & Portals (5758)	Reclaim 6 acres of spoil							6	600		\$81,000	\$16,200	\$100,000

Site name (Problem area no.)	Summary	Avg flow (gpm)	Design flow (gpm)	pH	Acidity (mg/L)	RAPS cost	Portal seals	Recl. area (acres)	OLC (ft)	MRB cost	Total const. cost	Engineering & project management	Grand total (Rounded)
Streams not listed as impaired													
Cooks Run													
Sharp's Highwall (2409)	Reclaim 1/2 of bench. No load							2	200		\$27,000	\$5,400	\$30,000
Cooks Run AMD, Highwall & Portals (5004)	Build treatment for water from portal	15	30	2.7	583	\$190,909	3	0	300	\$13,395	\$229,804	\$45,961	\$280,000
Fields Creek													
Boyd Run Strip South (2785)	Reclaim refuse							9	900		\$121,500	\$24,300	\$150,000
Little Laurel Run													
Three Forks Refuse #4 & #5 (1731)	Reclaim a little gob							2	200		\$27,000	\$5,400	\$30,000